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PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

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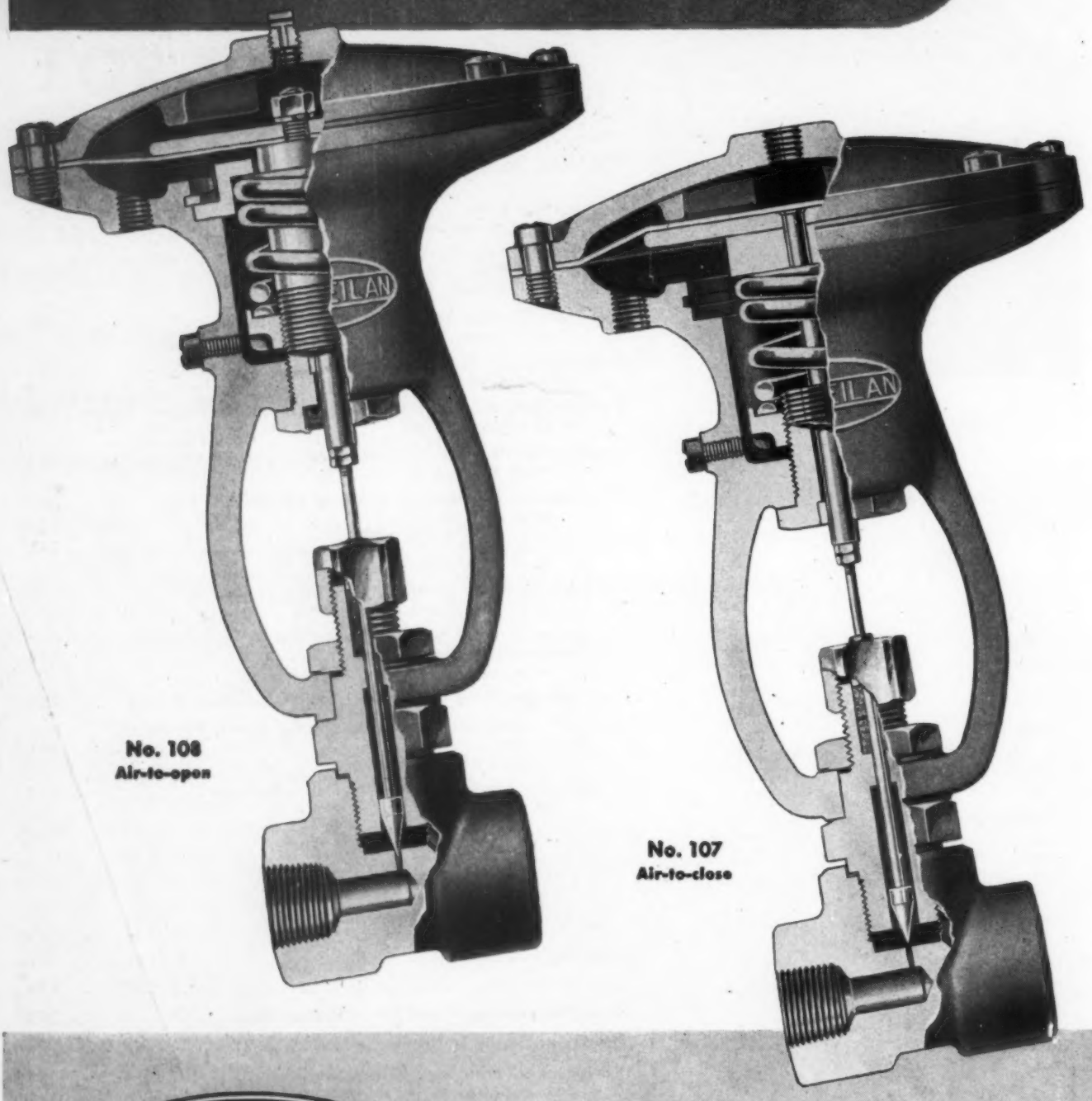

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VOLUME 26, NO. 2 FEBRUARY, 1947

PETROLEUM
REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

A GULF PUBLISHING COMPANY PUBLICATION

THE LOOK BOX

IT IS to be hoped that no legislation will be passed "to curb labor." Restrictions are not proper for individuals in the American scheme of things and they foster a growth to bring on more restrictions. In fact, the present attitude toward labor is the consequence of a similar attitude ten years back toward the capital division of industry.

Rights and Restrictions

At that time the element within industry that was branded as capitalistic was under inquiry and it was politically profitable to pass legislation to curb the capitalist. The result was the Wagner Act, an unfair piece of legislation. Under its privileges the labor section of industry has grown powerful and autocratic. Now it is popular to single out the labor leader as a culprit and pass legislation which will restrict the proper rights of other men.

What is needed is revision of what was done in the Wagner Act. If the element of management within industry had its just rights, such activities as collective bargaining could be conducted. Then when a man or men within labor asked men to go on strike, men within management could plead with the same men not to go on strike. There is fair play in activity such as that and fair play is all that industry needs, whether it is the management part of industry or the labor element of industry.

Men in industry need the privilege of solving their problems and settling their controveries rather than restrictions, which hamper or prevent settlement. Freedom is a healthy atmosphere, even when two men sit down to talk about a little matter of wages and hours.

IN ITS January advertising Ethyl Corporation has done a good turn for itself and for the petroleum industry by giving a fact in an effort to correct misunderstanding as reported in the survey of public opinion on which the industry is now basing its public-relations program. In a letter explaining why this copy theme had been selected, Ralph S. Clark said "most people think there are only a few companies in the industry." The advertisement asked readers to guess the number, offering figures from 24 to 240,000 with the correct answer at hand. And further from the letter:

With But One Stone

"It occurred to us that by telling several million people that 240 oil-refining companies use our product and thousands of companies market gasoline it has helped to improve, we could advertise our own business and at the same time help correct one of the large and more harmful areas of public misunderstanding about the oil industry."

The approach is recommended to other elements

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LIKE THE PIONEER days when they stripped the hide and tallow from range cattle and left the beef on the prairies, the days of burning off gas in open flares after it has lifted one load of oil to the surface will soon be gone forever.

Process plants to harvest valuable hydrocarbons from gas now wasted, releasing the dry gas for fuel or storing it back in the ground for future use, have doomed the squandering gas flares.

In the field of repressuring and recycling, Brown & Root, Inc., offer complete service, from design through engineering, fabrication and erection, all in one good organization.

BROWN & ROOT, Inc.

in the industry, whose good deeds far outnumber its bad. Any company can do itself a good turn as well as benefit the industry by giving facts which will correct public misunderstanding.

Lower Level

ONE objection to the creation of commissions, boards and other agencies of government is the fact that they provide resting places for men and women whose political viewpoint is at variance with the statute by which these agencies are created. The fellow-traveler has a vehicle when government sets out to rule by agency.

As an instance in the disposal of land acquired for use during the war period, the War Assets Administration has been reserving mineral rights. When Ed Gossett, Texas representative, questioned this practice, and cited the surplus-property-disposal act, he was assured that the practice would cease and that mineral rights already reserved would be given purchasers.

In a report on activity in Washington, Russell B. Brown, counsel of the Independent Petroleum Association of America, observed:

"Mr. Gossett is convinced that such reservations were made without the knowledge of top policy officials of WAA."

Recently W. L. Clayton, Under Secretary of State for Economic Affairs, gave the petroleum industry this assurance:

"The State Department has no policy or program which contemplates the creation of a petroleum-regulatory body and the pending Anglo-American Oil Agreement will provide neither a basis for the government regulation of the domestic or foreign petroleum industry nor for an extension of governmental powers with respect to the industry."

If such is the policy of the Department of State, one wonders how its policy-making officials can tolerate the public statements of men much lower down in the affairs of the department. In statements for print and over the radio, men in the department have set forth activities which leave the opportunity for such regulation so evident that the industry is fearful.

This conflict is of such portent that there can be little doubt that the department has personnel whose leanings are so bent on international cooperation that the result would be regulation at home.

Another opportunity for the fellow-traveler is in the promulgation of the reciprocal-trade agreements. Oil is but one industry whose affairs are subject to influence in these agreements. Seven agencies of the federal government have roles in these agreements: State, War, Navy, Treasury, Commerce, Agriculture and the U. S. Tariff Commission. A panel committee from these departments has been holding hearings in Washington, and Russell B. Brown has been before it with results not too satisfactory. In reporting on his experience, he noted that this committee also is giving attention to other industries under the general classification of chemicals, all of which brought this observation:

"I cannot decide whether petroleum still occupies a position of so little importance to the industry philosophy of those who are pushing the reciprocal trade agreement and international trade organization programs, or whether it has been decided that a convenient way to bury it is to throw our case in with tapioca."

That industry should cooperate with government is accepted. It should be accepted that individuals put into positions lower than the policy level in government cooperate both with government and with industry.

Canol Finis

IF A buyer can be found, the refining facilities of the Canol project will pass from the list of assets left to the United States at the close of the recent big war. It has taken an agreement with the Canadian government which "should result in obtaining the maximum monetary return since there will be no import tax or other assessments made on the property if utilized wholly or partially in Canada" or in case no disposition has been made in Canada within two years, "the United States at its option may either remove the property or leave it in situ as being of no value unless put to beneficial use."

Further from the news release through the Department of State:

". . . it is doubtful that any governmental or private agency will desire to acquire the pipe line and refinery for use in place. Therefore, dismantling of either facility will be permitted, and the objective of the disposal agency will be to obtain the maximum monetary return in the disposition of the property consistent with the requirements of the Surplus Property Act . . . the target date for opening bids being march 20, 1947."

The word "target" in the news release is the only visual reminder that the Canol venture is a monument to the stupidity of Army officers who put the plant in operating status at a cost of something like $130,000,000, or was it $140,000,000, despite the admonitions of men in other agencies of the government as well as individuals within the petroleum industry.

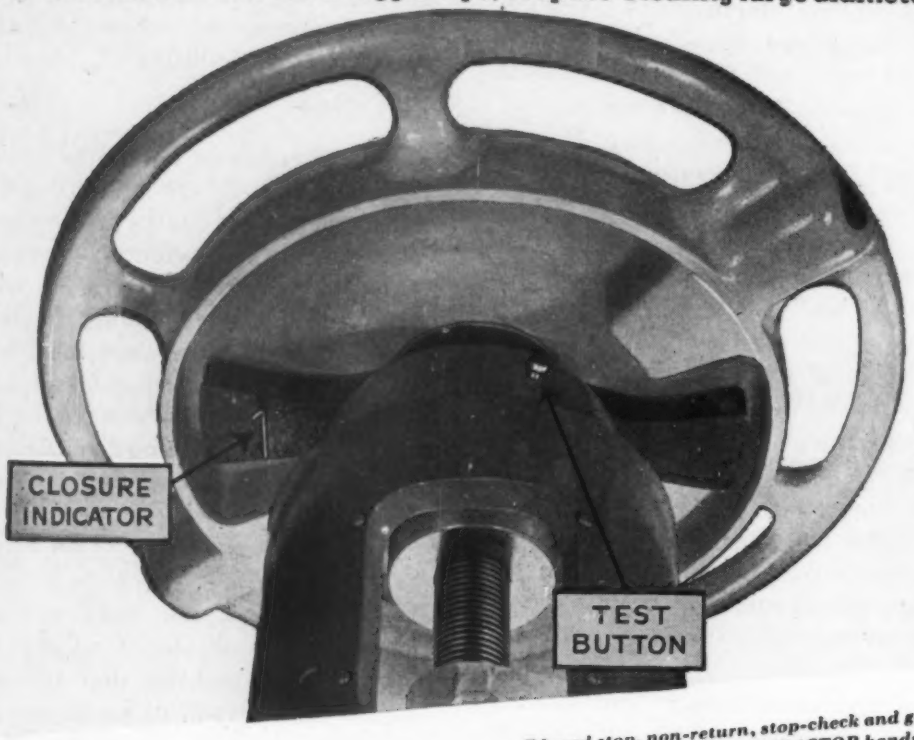
It would seem like even-handed justice if the Army, especially the men responsible for the venture, had to go forth and strive to sell it.

AN EDWARD CONTRIBUTION TO BETTER VALVE PERFORMANCE—THE IMPACTOR HANDWHEEL

How the *Edward* Impactor Handwheel closes big valves in little spaces

Where great torque is necessary to close a valve against high pressures —particularly in cramped areas— no operating device is as effective as the Edward IMPACTOR handwheel.

The IMPACTOR handwheel, an exclusive and patented Edward development, sees to it that a valve shuts tight against extreme pressures without extension levers, gear series, cumbersome toggle tops, or space-stealing large diameter wheels.



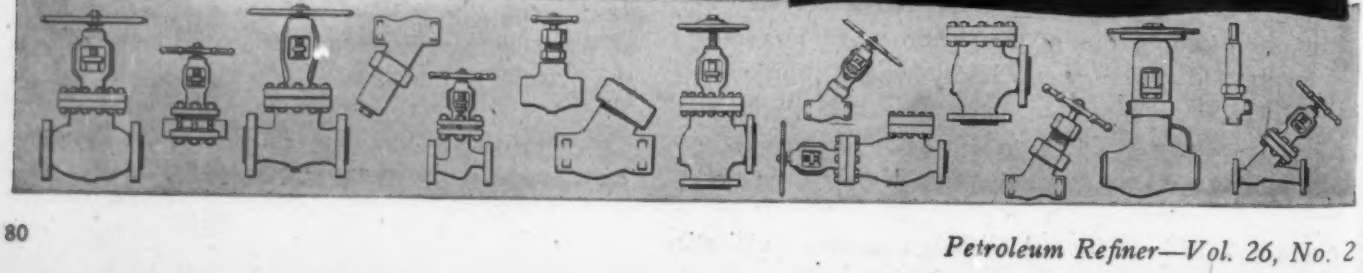
Notice—
- how the two heavy lugs, cast integrally with the wheel at 180°, strike simultaneous hammer-blows on the cross arm attached to the stem —making a positive shut-off.
- ample strength for any operating emergency.
- closure indicator and test button.
- how simple and well balanced the whole mechanism is, how little space it takes up.

Edward IMPACTOR equipped valves, in most sizes, also have Edward patented EValthrust yoke bushing for additional thrust capacity and smooth operation.

Edward stop, non-return, stop-check and gate valves are regularly furnished with IMPACTOR handwheels, in the following sizes and pressures:

5 in. and larger 1500 lb; 6 in. and larger 900 lb; 8 in. and larger 600 lb; 10 in. and larger 300 lb.

Edward Valves, Inc.
Subsidiary of Rockwell Manufacturing Company
EAST CHICAGO, INDIANA



Refinery Gas Fuels

L. A. MEKLER, Engineering Consultant, Armour Research Foundation*
and
C. G. VON FREDERSDORFF, Associate Chemical Engineer
Institute of Gas Technology

MODERN refining requires accurate control of temperature of the materials leaving the heater of the processes. Gas firing is easiest to control, particularly automatically, and gas, therefore, is the preferred fuel for heaters of all processing units. In the past, when refinery operations were directed primarily to the production of gasoline, overhead fuels and residual fuels by thermal cracking and atmospheric distillation, the refinery gases produced by the cracking units and burned practically in their entirety through the C_4 and C_5 were more than sufficient to meet the fuel requirements not only of the processing units, but of the boilers as well. Liquid fuels and natural gas were used only when the cracking units were off stream or were not producing their normal amount of gas.

Present-day intensive processing of crude requires more fuel per barrel of the crude processed than in the past. On the other hand, the supply of refinery gases for fuel is proportionately much less because in practically all refineries an appreciable portion of the gases formerly burned is processed to obtain gasoline components or intermediate or finished chemicals. In some refineries as much as 40 percent of the heat value of the gases is taken out by such processing before the gases are sent to the fuel system of the refinery.

The gases from catalytic-cracking units available for fuel are, in general, just sufficient to meet the fuel and power requirements of these units and of their auxiliaries, such as stock-preparation, gas-concentration and distillation units. Therefore, in most refineries there is at present an overall deficiency of refinery gases to meet the fuel requirements, and natural gas in constantly increasing proportions is used where available, so that at least the heaters of the refinery units most sensitive to firing conditions can be fired with gas at all times. The gases burned in most refineries are blends of C_3 and lighter refinery gases from thermal- and catalytic-cracking units with natural gases and with excess C_4 over the vapor pressure requirements of the motor fuels produced.

Typical Gases

Tables 1, 2, 3 and 4 show the properties of typical refinery gases and natural gases used by themselves or as blending components for refinery fuels. Table 5 shows typical blended gaseous fuels actually used in some refineries. The calorific values, specific gravities, theoretical air requirements and the properties of the theoretical mixture of gas and air given in these tables were calculated from the values in Table 6 for the physical properties and combustion characteristics of the hydrocarbons and other primary constituents of these gases.

The gases shown in Tables 1 to 5 cover the whole range of refinery gases as burned in various refineries and vary from 1095 to 2000 Btu per cubic foot in calorific value; from 0.60 to 1.15 in specific gravity and from 10 to 19 cubic feet of air per cubic foot of gas required theoretically for complete combustion. The variation of properties of the hydrocarbon constituents of these fuels as shown in Table 6 are even wider. However, in the two most important properties which determine their behavior as fuels, the calorific value of the theoretical gas-air mixture and the specific gravity of the mixture, the various gases are very much alike. With all of them, the theoretical gas-air mixture has a calorific value of 100 Btu per cubic foot and a specific gravity of 1.0 plus-minus 2 percent. The variation in these values is somewhat greater for the basic gas constituents but since practically all refinery gases contain hydrogen and methane which give a mixture with a calorific value of 96 and a specific gravity 0.75 and 0.96, respectively, these lower values usually compensate for the higher values of the other hydrocarbons so that in the normal blends of refinery gases as actually burned variations greater than 2 percent from the average values of 100 Btu and 1.0 specific gravity are quite rare.

Gross Calorific Values of Refinery Gases

Figure 1 shows a plot of calorific values of different refinery fuel gases against their gravity. The points for the different gases fall very closely to a straight line. The relationship between the calorific value and specific gravity as represented by the straight line is expressed by the formula:

$$C_v = 215 + 1500g, \qquad (1)$$

where C_v is the gross calorific value, Btu per cubic foot, and g the specific gravity of the gas, both on inert free basis.

Actual determination of calorific value and of specific gravity of gases are seldom closer than the deviation of the various points from the straight line on the figure. Therefore the relationship as shown by this straight line is sufficiently accurate for most combustion and heat-balance calculations.

Since all gases in Tables 1 to 5 have a calorific value of 100 Btu per cubic foot of theoretical gas-air mixture, within an accuracy of plus-minus 2 percent, the theoretical air requirements for these gases can be expressed by the relationship,

$$A_v = \frac{C_v}{100} - 1,$$

where A_v is the theoretical air required per cubic foot of gas, and C_v the calorific value as above.

By substituting the value of C_v from (1), the theo-

* Present address, 21 E. Van Buren, Chicago 5, Illinois.

retical air requirements can be expressed in terms of specific gravity by

$$A_v = 1.15 + 15g, \text{ in cu. ft./cu. ft. of gas} \quad (2)$$

and

$$A_m = \frac{1.15}{g} + 15, \text{ in lb./lb. of gas} \quad (3)$$

These relationships are shown on Figure 1 by the curved line for A_m and by the lower straight line for A_v.

TABLE 1

Refinery Fuel Gases from Thermal Processes

GAS	1	2	3	4	5	6	7	8
Composition, Vol. Percent:								
H_2	9.8	3.3	4.0	7.5	5.7	6.2	5.7	2.8
C_1	45.9	36.0	47.0	35.5	32.6	29.5	25.6	21.6
$=C_2$	19.5	5.4	3.0	2.9	3.7	6.7	6.1	6.8
C_2	3.7	18.2	18.5	24.8	22.3	18.7	24.0	23.2
$=C_3$	11.3	7.5	9.0	9.4	12.8	14.2	14.0	19.5
C_3	6.6	19.7	18.0	18.8	19.9	23.7	19.1	19.3
C_4+	3.2	1.9	0.5	1.1	3.0	1.0	5.5	6.8
Inerts	....	....	....	....	8.0	....	....	....
Olefins	30.8	12.9	12.0	12.3	16.5	20.9	20.1	26.3
H_2, Wt. Percent	20.1	19.8	20.4	19.9	19.3*	18.9	18.7	18.3
Calorific Value, Gross, Btu./cu. ft.	1425	1538	1564	1619	1723*	1741	1812	1938
Specific Gravity (Air=1)	0.82	0.88	0.90	0.94	1.01	1.03	1.07	1.15
Theoretical Gas-Air Mixture*:								
Air, cu. ft./cu. ft of gas	13.1	14.2	14.6	15.7	16.3*	16.2	17.1	17.9
Specific Gravity (Air=1)	0.99	0.99	1.00	1.00	1.00	1.00	1.01	1.02
Calorific value, gross, Btu./cu. ft.	101	101	100	103	100	100	100	101

* Inert free basis.
Gas 1—Coking, Gases 5 and 6—Reforming, Remainder—Cracking.

TABLE 2

Refinery Fuel Gases from Thermal Processes After Polymerization

Gas	1	2	3	4	5	6	7
Composition, Vol. Percent:							
H_2	10.8	3.5	5.2	3.8	7.0	6.4	3.4
C_1	50.7	38.5	38.6	40.2	33.5	29.2	25.9
$=C_2$	4.1	5.8	3.2	3.3	7.6	6.9	5.0
C_2	21.6	19.5	27.0	21.2	21.2	27.3	27.8
$=C_3$	2.0	2.1	1.0	1.1	2.6	2.3	3.7
C_3	7.3	21.0	20.8	23.8	27.0	21.7	23.1
C_4+	3.5	2.0	1.2	6.6	1.0	6.2	8.1
Inerts	....	8.6	....	....	....	....	....
Olefins	6.0	8.6*	4.2	4.4	10.2	9.2	11.7
H_2, Wt. Percent	21.8	19.6*	19.8	20.0	19.8	19.7	19.2
Calorific Value, Gross, Btu./cu. ft.	1372	1503*	1555	1617	1671	1730	1859
Specific Gravity (Air=1)	0.74	0.87*	0.89	0.99	0.95	1.02	1.10
Theoretical Gas-Air Mixture*:							
Air, cu. ft./cu. ft. of gas	13.2	13.9	14.7	15.2	15.7	16.1	17.8
Specific Gravity (Air=1)	0.98	0.99	0.99	1.00	1.00	1.00	1.00
Calorific Value, Gross, Btu./cu. ft.	103	101	99	100	100	101	99

* Inert free basis.
Gases 1 and 3—Coking, Gases 6 and 7—Reforming, Remainder—Cracking.

TABLE 3

Refinery Fuel Gases from Catalytic Cracking Processes

Gas	1	2	3	4	5	6	7	8	9
Composition, Vol. Percent									
H_2	18.0	15.5	19.5	11.8	11.2	5.5	3.8	6.0	3.4
C_1	36.8	62.0	24.6	35.2	22.8	31.7	18.7	15.0	14.5
$=C_2$	21.2	17	8.2	6.6	11.2	7.0	5.1	7.6	7.4
C_2			9.6	9.3	8.5	8.7	10.0	10.2	10.1
$=C_3$	1.5	4.6	10.0	9.3	15.6	15.1	18.8	28.2	35.2
C_3			20.6	19.8	22.4	24.7	27.1	33.0	19.7
C_4+	0.5	0.8	....	0.4	....	0.4	....	....	5.2
Inerts	22.0	....	7.5	7.1	7.3	6.5	16.5	....	4.5
Olefins*	....	....	18.2	17.7	28.8	23.8	....	33.5	44.6
H_2, Wt. Percent	....	....	20.0	19.9	18.5	18.7	18.6	17.5	15.8
Calorific Value, Gross, Btu./cu. ft.									
As burned	843	....	1384	1481	1532	1609	1606	....	1969
Inert free	1080	1170	1490	1590	1660	1720	1920	1992	2050
Sp. Gravity (Air=1)*	0.59	0.61	0.83	0.90	0.99	1.02	1.14	1.19	1.24
Theoretical Gas-Air Mixt.*:									
Air, cu. ft./cu. ft. of gas	10.0	10.3	13.7	14.6	15.3	15.9	17.9	18.4	19.3
Specific Gravity (Air=1)	0.96	0.97	0.98	1.00	1.00	1.00	1.01	1.01	1.00
Calorific Valve, Gross, Btu./cu ft.	98	98	102	102	102	101	101	98	101

* Inert freebasis.
Gases 1, 6 and 9—Fluid Process.
2, 4 and 7—Houdry Process.
3, 5 and 8—Thermofor Process.

Hydrogen Content of Refinery Gases

The refinery gases shown in the tables vary in hydrogen content from 17.0 to 24.2 percent by weight. The majority of the gases as burned fall within the range of 18.5 and 21.5 percent. There is no direct relationship between the calorific value or the specific gravity of these gases and their hydrogen content because of the many possible combinations of the hydrocarbon constituents which give the same carbon-hydrogen ratios. The hydrogen content of the gases can be determined reasonably close from a relationship between the air requirements per pound of gas, A_m, and the theoretical air required to burn a pound of mixture of carbon and hydrogen with the same hydrogen content by weight as the gas.

According to formula (3) the weight of air required to burn one pound of any refinery gas is

$$A_m = 15 + \frac{1.15}{g}$$

On the other hand the weight of theoretical air required to burn a pound of mixture of carbon and hydrogen is

$$A_n = 34.3\ H + 11.5\ (1\text{-}H) = 22.8\ H + 11.5 \quad (4)$$

where 34.3 and 11.5 are, respectively, pounds of theoretical air required to burn a pound of hydrogen and a pound of carbon, and H is the weight fraction of hydrogen in the mixture.

A plot of A_m against the hydrogen content of the gases as listed in the tables gives a scatter diagram with the median curve higher than the corresponding points of A_n by a value which can be expressed as functions of the gas gravities

$$a = 1.15\ (g - 0.7) \quad (5)$$

Equating (3) and (4) with correction (5), the rela-

TABLE 4

Natural Gas Fuels

Gas	1	2	3	4	5	6
Composition, Vol. Percent:						
C_1	94.2	87.0	82.3	80.5	86.5	84.0
C_2	4.3	8.0	7.0	12.1	6.4	8.0
C_3	1.3	3.9	2.1	4.2	3.2	3.5
C_4	0.2	0.6	1.0	....	2.3	3.5
Inerts	....	0.4	7.6	3.2	1.6	1.0
H_2, Wt. Percent*	24.2	23.6	23.7	23.3	23.2	23.2
Calorific Value, Gross, Btu./cu. ft.:						
As burned	....	....	1047	1142	1190	1210
Inert free basis	1075	1146	1160	1182	1205	1222
Specific Gravity (Air=1)*	0.59	0.63	0.64	0.65	0.66	0.67
Theoretical Gas-Air Mixture*:						
Air, cu. ft./cu. ft. of gas	9.9	10.7	10.6	11.0	10.9	11.2
Specific Gravity (Air=1)	0.96	0.97	0.97	0.97	0.98	0.97
Calorific Value, Gross, Btu./cu. ft.	99.5	99	100	99	99	100

* Inert free basis.
The specific gravities of the gases as burned are within plus-minus 0.02.

TABLE 5

Mixed Refinery Fuel Gases

Gas	1	2	3	4	5	6
Composition, Vol. Percent:						
H_2	20.9	2.6	3.3	3.3	6.8	* 2.0
C_1	27.3	53.3	36.0	36.9	21.6	24.6
$=C_2$	23.5	1.9	5.4	3.2	7.3	6.2
C_2		19.0	18.2	18.9	13.4	19.3
$=C_3$	21.4	6.1	7.5	6.7	15.7	9.2
C_3		13.6	19.7	21.3	29.4	28.7
C_4+	3.0	0.7	1.9	9.5	....	5.4
Inerts	3.9	2.8	8.0	1.5	5.8	4.6
Olefins*	....	15.9	14.0	10.0	23.4	16.2
H_2, Wt. Percent	20.6	20.1	19.6	19.4	19.4	19.6
Caloric Value, Gross, Btu./cu. ft.:						
As burned	1380	1435	1540	1728	1700	1828
Inert free basis	1430	1480	1670	1760	1805	1930
Specific Gravity (Air=1)*	0.83	0.85	0.97	1.05	1.06	1.15
Theoretical Air-Gas Mixture*:						
Air, cu. ft./cu. ft. of gas	13.4	13.9	15.7	16.5	16.9	18.0
Specific Gravity (Air=1)	0.99	0.99	1.00	1.00	1.00	1.00
Calorific Value, Gross, Btu./cu. ft.	99	99	100	100	101	101

* Inert free basis.
The specific gravity of the gases as burned are within plus-minus 0.03.

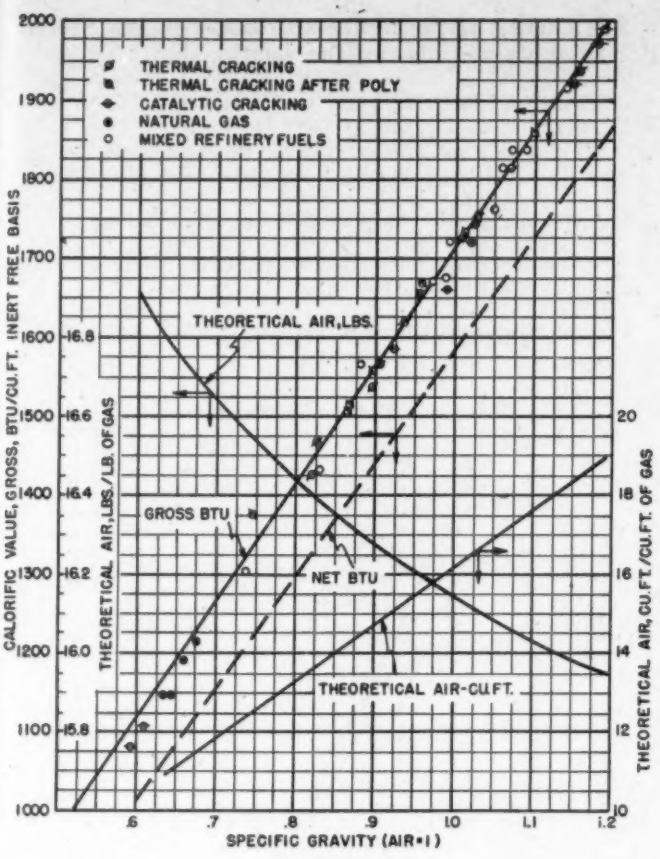


FIGURE 1

Average properties of refinery fuel gases as a function of their gravity.

tionship of hydrogen content by weight and the specific gravity of the gas becomes

$$15+\frac{1.15}{g}=22.8\,H+11.5+1.15\,(g-0.7)$$

or

$$H=.188+\frac{1.15\,(1-g^2)}{22.8\,g}$$

$$=.188+\frac{.05\,(1-g^2)}{g} \qquad (6)$$

This relationship is shown on Figure 2 together with points of hydrogen content versus specific gravity of a number of gases from the tables and other sources.

Calorific Value of Refinery Gases

The net calorific value of the gases can be expressed as a function of the gravity of the gas and the hydrogen content-gravity relationship as shown on Figure 2, by the following derivation.

Weight of 1 cubic foot of any gas $=\frac{g}{13.06}$; where 13.06 is the volume of air, cubic feet per pound, (Table 6) and g is the gravity of the gas. A gas containing H weight-percent of hydrogen will contain

$$\frac{g}{13.06}\times\frac{H}{100}\text{ lbs. of }H_2\text{ per cu. ft. of gas}$$

Each pound of hydrogen will produce 9 pounds of steam with a total heat content of 1040 Btu per pound above 60° F. (ASTM standard value for efficiency calculations.) The heat loss due to the hydrogen in the gas per cubic foot of gas is therefore

$$Q=\frac{g\times H\times 9\times 1040}{13.06\times 100}\qquad\text{Btu}\qquad(7)$$

By substituting from (6) for the value of H, the difference between the gross and net calorific value of the gas, becomes after simplification,

$$Q=60+75\,g.\qquad\text{Btu}\qquad(7a)$$

The dotted line on Figure 1 shows the generalized net calorific values of refinery gases derived from their gross values and the relationship in (7a). The values as given by the line are correct within plus or minus 2 percent for the whole range of gravities shown.

Combustion Characteristics of Refinery Gases

The curves on Figures 1 and 2 can be used to obtain from their gravity alone the calorific value, theoretical air requirements and hydrogen content of refinery fuel gases, with an accuracy sufficient for most engineering-design and thermal-efficiency calculations. For example, a refinery fuel has a gravity of 0.90 as obtained by an accurate weight determination. From Figure 1 the gas has a gross calorific value of 1565 Btu per cubic foot and requires 14.7 cubic feet of air per cubic foot of gas or 16.28 pounds of air per pound of gas. From Figure 2 the gas has a hydrogen content of 19.9 percent by weight. Gases 3 in Tables 1 and 2 and gas 4 in Table 3 with gravities of 0.90, 0.89 and 0.90 have calorific values of 1564, 1555 and 1590; hydrogen contents of 20.4, 19.8 and 19.9 and require 14.6, 14.7 and 14.6 cubic feet of air per cubic foot of gas, a deviation from the values in the figures well within limits for practical calcula-

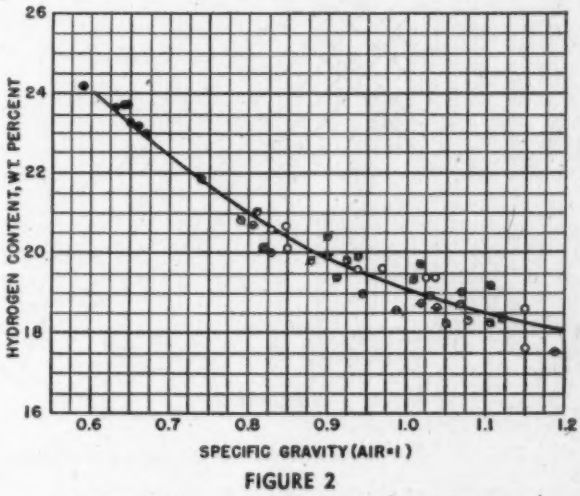


FIGURE 2

Average hydrogen content of refinery fuel gases.

tions and within the accuracy of laboratory determination of these values.

Figure 3 shows the combustion characteristics of refinery gases with different hydrogen content, percent by weight, when burned with excess air from 0 to 120 percent of the theoretical requirements. Since the majority of the gases shown on the tables and represented in Figure 1 have hydrogen contents varying between 17 and 23 percent by weight, a good approximation of these characteristics for all refinery gases can be obtained from the lines for hydrocarbons with 19 percent hydrogen by weight. The values for the curves in Figure 3, and in Figures 4 and 5 which follow, are derived from the basic equations as given at the end of the article.

Figures 4 and 5 show the combustion characteristics of two gases on the low and on the high side of the range of refinery fuels normally burned. The calorific value of the gas in Figure 4 is 1360 Btu per

cubic foot, its hydrogen content is 21 percent, it requires 12.4 mols of theoretical air per mol of gas and gives 12.9 percent CO_2 (dry basis) in the flue gases with theoretical air and 6.1 percent with 100 percent excess air.

The calorific value of the gas on Figure 5 is 1720 Btu per cubic foot, its hydrogen content is 18.8 weight percent, it requires 16 mols of theoretical air per mol of gas and gives 14.2 and 6.9 percent CO_2 with theoretical and 100 percent excess air, respectively. The difference between these two gases appears to be rather large. However, the flame-burst

The curves in the figure are based on the Stefan-Boltzmann equation and the relationship

$$\frac{Q_g}{Q_r} = \frac{T_g - 520}{T_g - T_f} \text{ where}$$

Q_g is the amount of heat, in Btu above 60° F., liberated by the gas per square foot of "effective" surface;
Q_r—the amount of heat absorbed by radiation;
T_g—the flame burst temperature °Rankine
T_f—the residual or "effective radiation" temperature of the furnace °Rankine.

Figure 8 shows the evaluation of various types of

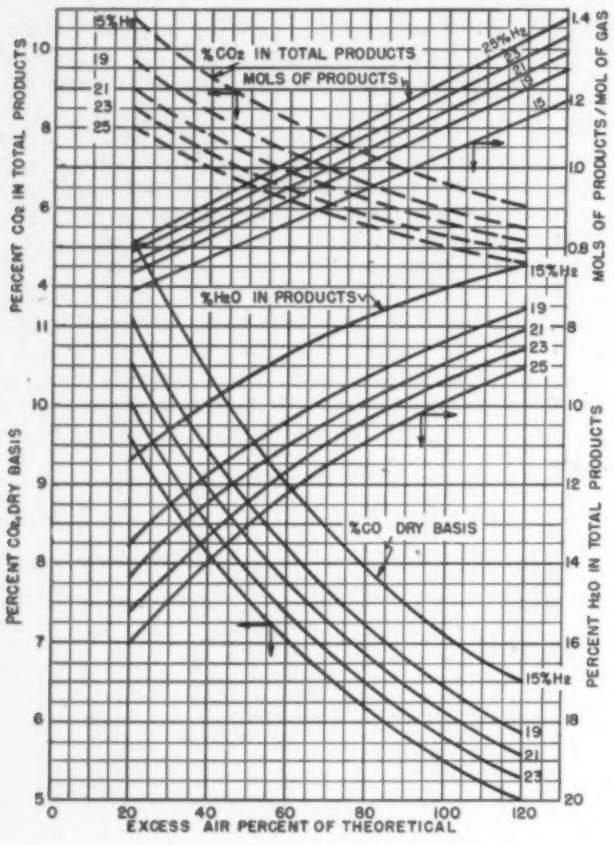


FIGURE 3a

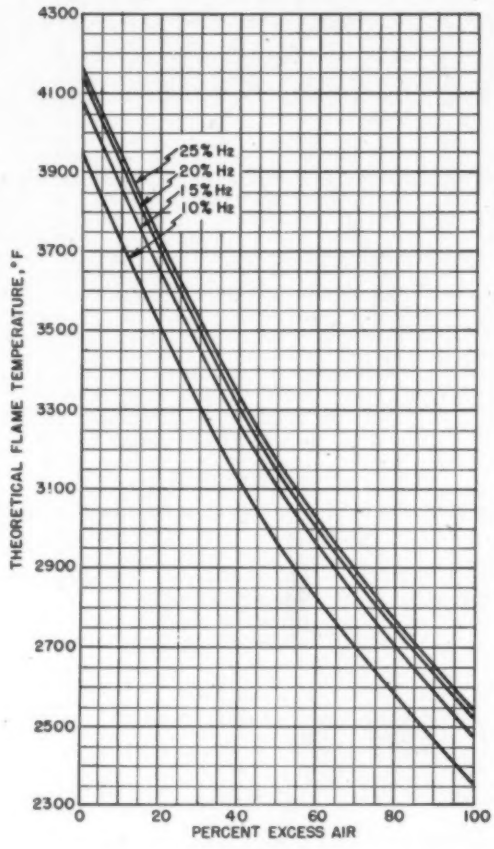


FIGURE 3b

Combustion characteristic of refinery fuel gases with different hydrogen content.

temperature and the sensible-heat content of the products of combustion of the two gases, the two properties which determine the radiant- and convection-heat transfer from these two fuels are very close together. For example, without air preheat and 40 percent excess air the flame-burst temperature of the 1360 Btu gas is 3300° F. and the sensible-heat content is 27,900 Btu per mol of combustion products. The corresponding values for the 1720-Btu gas are 3320°F. and 28,500 Btu. The values are practically identical with those for the leaner gas. Arithmetic means of the heat contents and the flame-burst temperatures as shown on Figures 4 and 5 can be used in most calculations for any refinery gas burned with an excess air between 20 and 100 percent. More accurate values for specific gases can be obtained from Figure 3.

Figure 7 shows the relationship of radiant-heat-transfer rates to surfaces at different temperatures as a function of the total heat liberated from the fuel, as derived from the net calorific value of the gases, and the flame-burst temperature.

tube banks as a fraction of the effective surface used in Figure 7. The curves in Figure 8 are derived from relative effectiveness of tube banks in a plane as the effectiveness is dependent on the number of rows in the bank and the center-to-center spacing of the tubes, as shown on Figure 9, and from the "cold fraction" of the tube banks as illustrated for a cubical furnace chamber in Figures 10 and 11.

Velocity of Flame Propagation

Figure 12 shows the velocity of flame propagation of mixtures of different hydrocarbons and air, as observed in a 5-cm tube, plotted against percentage of theoretical air in the gas-air mixture. This plot is somewhat different from the plot commonly used to represent this data as shown on Figure 13 where the percentage of gas in the gas-air mixture is used as the ordinate. As plotted on Figure 12 all of the major gas constituents with the exception of hydrogen have a maximum flame-propagation velocity when supplied with 80 to 100 percent of the theoreti-

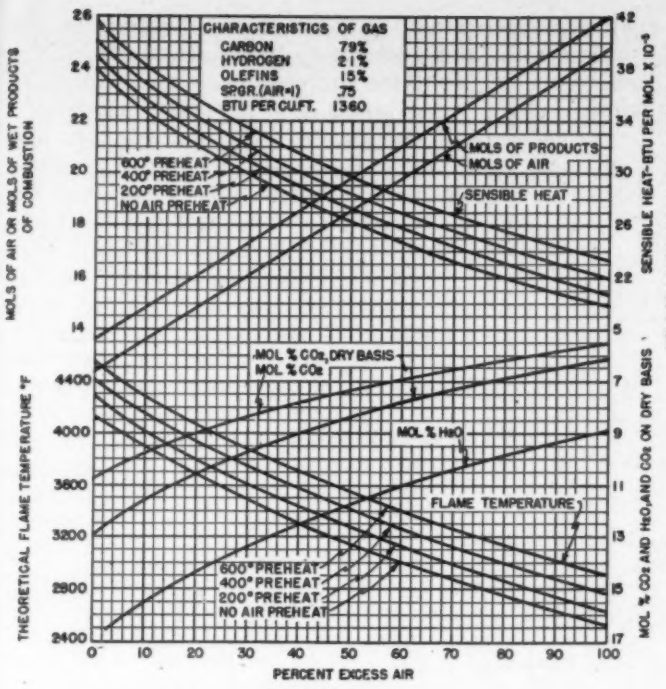


FIGURE 4

Combustion characteristics of 1360-Btu mixed refinery gases.

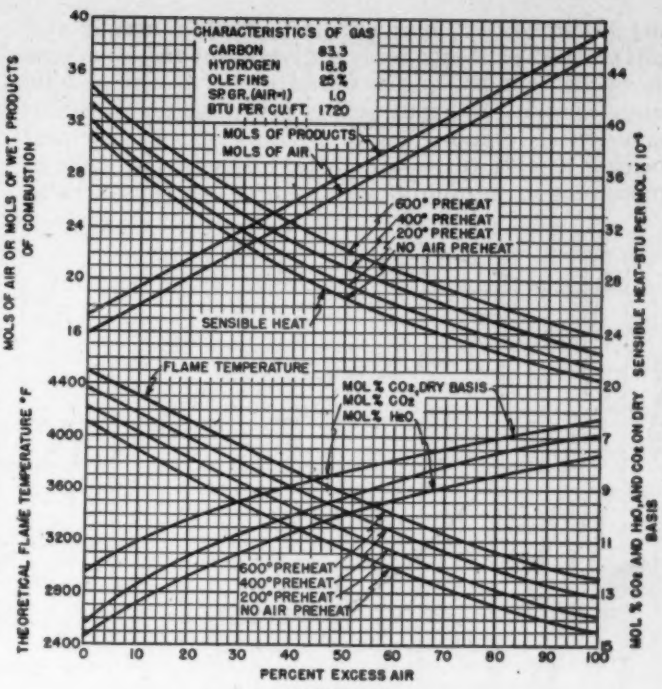


FIGURE 5

Combustion characteristics of 1720-Btu mixed refinery gases.

cal air. It is, therefore, reasonably safe to assume that, with the exception of the natural gases when burned alone, all refinery fuel gases will possess approximately the same ignition characteristics, particularly since methane and ethylene affect the flame propogation velocity of a mixture in opposite directions, thus tending to compensate for each other. Similarity of ignition characteristics of all refinery gases is very important when different types of fuel have to be occasionally burned in a given heater, such as starting on natural gas alone and normally firing it with relatively rich gases from thermal- or catalytic-cracking units, or with a mixture of these gases with small amounts of natural gas.

The similarity of the properties of the gas-air mix-

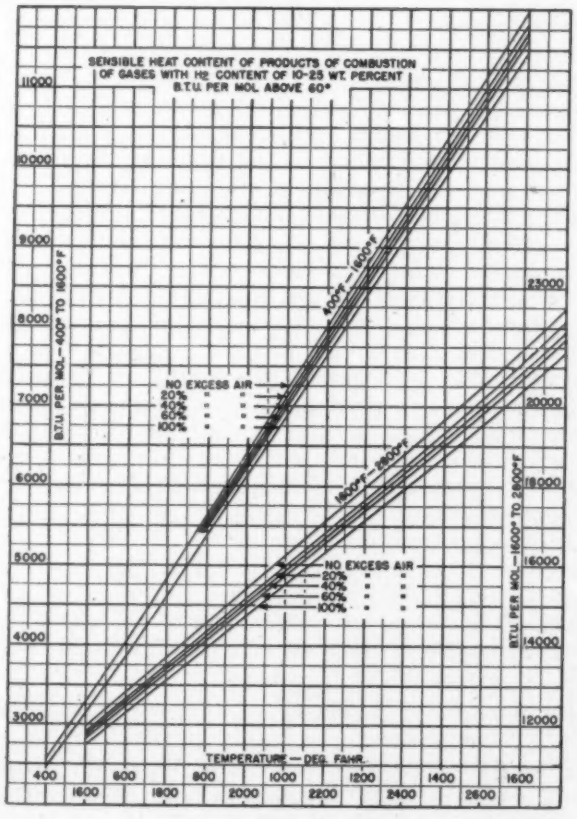


FIGURE 6

Heat content of products of combustion of refinery gases.

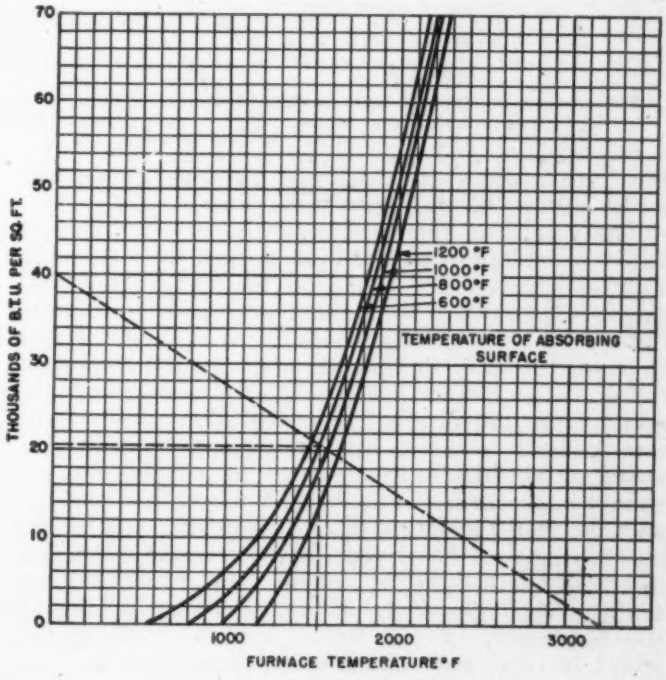


FIGURE 7

Radiant heat transfer relationships.

Example.

Flame burst temperature, T_f, °F.	3100
Heat liberated, Btu/sq. ft. of effective surface	40000
Temperature of absorbing surface, °F.	800
Radiant heat absorbed, Btu/sq. ft. of effective surface	20200
Residual gas temperature, or "effective" temperature T_g, °F.	1550

tures, flame-burst temperatures, heat contents and inflammability limits with a given amount of excess air of all refinery gases, permits the use of a wide range of refinery gases in any given heater; particularly if it is equipped with burners of a design permitting a wide turn-down ratio; that is, the ratio of maximum to minimum gas-air mixture pressures at the burner ports at which the fires will not blow away from or backfire into the burner.

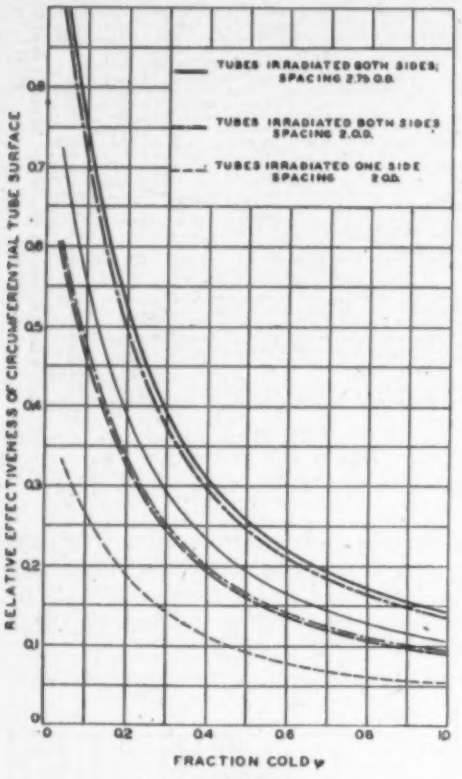

TUBES IRRADIATED BOTH SIDES; SPACING 2.75 O.D.
TUBES IRRADIATED BOTH SIDES SPACING 2 O.D.
TUBES IRRADIATED ONE SIDE SPACING 2 O.D.
RELATIVE EFFECTIVENESS OF CIRCUMFERENTIAL TUBE SURFACE
FRACTION COLD ψ

FIGURE 8

Effectiveness of radiant tube banks as determined by tube arrangement in heater.

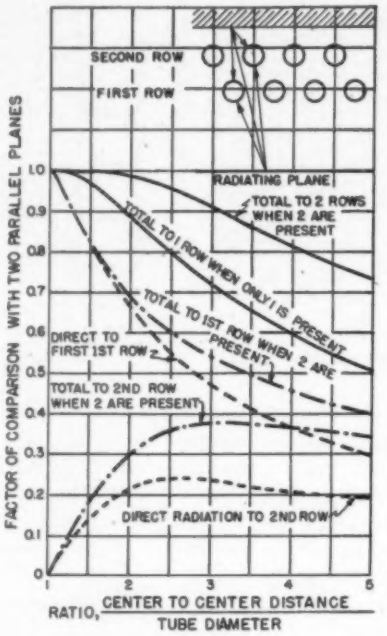

SECOND ROW
FIRST ROW
RADIATING PLANE
TOTAL TO 2 ROWS WHEN 2 ARE PRESENT
TOTAL TO 1 ROW WHEN ONLY 1 IS PRESENT
TOTAL TO 1ST ROW WHEN 2 ARE PRESENT
DIRECT TO FIRST 1ST ROW
TOTAL TO 2ND ROW WHEN 2 ARE PRESENT
DIRECT RADIATION TO 2ND ROW
FACTOR OF COMPARISON WITH TWO PARALLEL PLANES
RATIO, CENTER TO CENTER DISTANCE / TUBE DIAMETER

FIGURE 9

Effectiveness of radiant tube banks in a plane parallel to the radiating plane.

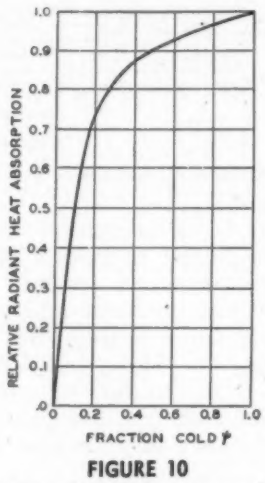


FIGURE 10

Effectiveness of tube banks as a function of cold fraction of the tube banks.

The burner ports at which the fires will not blow away from or backfire into the burner.

The values of flame temperatures in Figures 3, 4 and 5 and of the rates of radiant-heat absorption in Figures 8 and 9 are based on the assumption that the fuel is burned with short non-luminous flames obtained by premixing all of the air with the fuel in or at the tip of the burner, and that the total heat input to the radiant-heat-absorbing tubes comes directly from the product of combustion without the intermediate re-radiation to the tubes from the exposed refractories in the heater. The assumptions are valid for the *overall* radiant-heat absorption obtained with the *total* radiant surface of the heater and for the *average* rates of heat input to this surface. However, in actual heaters the radiant-heat input rates are not uniform throughout the heater and are affected by the luminosity of the flame and its shape factor, which in turn is governed by the composition of the products of combustion and the thickness of the gas layer acting as the radiator.

Flame Luminosity

The luminosity of the flame is determined by the extent of mixing of the fuel with the total air used at the point of ignition. Premixing of the total air with the fuel at the ignition point results in a non-luminous flame with all of the heat energy of the fuel liberated almost instantaneously at this point. Where only a portion of the total air is premixed with the fuel as primary air, incomplete combustion at the ignition point and a luminous flame are obtained, the luminosity of the flame increasing as the amount of primary air is decreased. By properly locating a burner of suitable design and by adjusting the ratio of primary to secondary air and the relative velocities and direction of flow of the ignited fuel and the secondary air streams so that the streams are in substantially parallel horizontal planes and are free of eddies, it is possible to obtain luminous flames of any shape and length to suit the shape of the furnace chamber and the location of the tube banks in the chamber. Luminous flames have a much higher emissivity (40-60 percent of black-body radiation) than non-luminous flames (15-20 percent). Because of the progressive combustion and heat release with luminous-flame firing, the maximum flame temperatures are lower and the furnace temperatures are more uniform throughout the length of travel of the gases than are normally obtained with flameless combustion. Also a greater portion of the available heat of the fuel can be applied as radiant heat with lower maximum gas and furnace temperatures than with non-luminous-flame firing. In some metallurgical furnaces luminous-flame firing is the standard procedure. In open-hearth furnaces the operating temperature is often close to the softening point of the refractories and any reduction of the peak temperatures in the furnace obtained by luminous-flame firing is very important.

Luminous-flame gas firing is not used in petroleum heaters to any extent. This is partly due to the troubles with overheated tubes in the early heaters where, because of poor burners then available and improper arrangement of the burners in the setting, poor ignition, long flames and secondary combustion near or through the tube bank were quite common.

TABLE 6*

Properties of Hydrocarbons and Other Constituents of Refinery Gas Fuels

Substance	Formula	Molecular Weight	Lbs. per Cu. Ft.[b]	Cu. Ft. per Lb.[b]	Specific Gravity Air = 1.000[b]	HEAT OF COMBUSTION[c] Btu per Cu. Ft. Gross	Btu per Cu. Ft. Net[d]	Btu per Lb. Gross	Btu per Lb. Net[d]	CU. FT. PER CU. FT. OF COMBUSTIBLE Required for Combustion O_2	N_2	Air	Flue Products CO_2	H_2O	N_2	LBS. PER LB. OF COMBUSTIBLE Required for Combustion O_2	N_2	Air	Flue Products CO_2	H_2O	N_2	Theoretical Fuel Air Mixture Btu/Cu. Ft.	Specific Gravity
Miscellaneous:																							
Carbon	C	12.01	.....	187.723	0.00959	.....	.....	14,093[e]	14,093[e]	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hydrogen	H_2	2.016	0.005327	187.723	0.06959	325.0	275.0	61,100	51,623	0.5	1.882	2.382	1.0	1.882	7.937	3.664	11.527	34.344	.....	8.937	96.1	0.76
Oxygen	O_2	32.000	0.08461	11.819	1.1053	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Nitrogen (atmos.)	N_2	28.016	0.07439[a]	13.443[a]	0.9718[a]	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Carbon monoxide	CO	28.01	0.07404	13.506	0.9672	321.8	321.8	4347	4347	0.5	1.882	2.382	1.0	1.882	0.571	1.900	2.471	.....	1.871	1.900	90.3	1.00
Carbon dioxide	CO_2	44.01	0.1170	8.548	1.5262	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Hydrogen sulphide	H_2S	34.076	0.09100[a]	10.979[a]	1.1898[a]	647	596	7100	6545	1.5	5.646	7.146	1.0	5.646	1.469	4.668	6.097	1.880	(SO$_2$) 0.529	4.668	90.1	1.04
Sulphur dioxide	SO_2	64.06	0.1733	5.770	2.264	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Water vapor	H_2O	18.016	0.04758[a]	21.017[a]	0.6215[a]	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Air	.....	28.9	0.07655	13.063	1.0000	.....	.....	.....	.....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....
Paraffin Series C_nH_{2n+2}:																							
Methane	CH_4	16.041	0.04243	23.565	0.5543	1013.2	913.1	23,879	21,520	2.0	7.528	9.528	1.0	2.0	7.528	3.990	13.275	17.265	2.744	2.246	13.275	96.2	1.00
Ethane	C_2H_6	30.067	0.08029[a]	12.456[a]	1.0482[a]	1792	1641	22,320	20,432	3.5	13.175	16.675	2.0	3.5	13.175	3.795	12.394	16.119	2.927	1.798	12.394	96.2	0.96
Propane	C_3H_8	44.092	0.1196[a]	8.365[a]	1.5617[a]	2590	2385	21,661	19,944	5.0	18.821	23.821	3.0	4.0	18.821	3.629	12.074	15.773	2.994	1.634	12.074	102.0	1.00
n-Butane	C_4H_{10}	58.118	0.1582[a]	6.321[a]	2.0665[a]	3370	3113	21,308	19,680	6.5	24.467	30.967	4.0	5.0	24.467	3.670	11.978	15.487	3.029	1.550	11.978	104.0	1.02
Isobutane	C_4H_{10}	58.118	0.1582[a]	6.321[a]	2.0665[a]	3363	3105	21,257	19,629	6.5	24.467	30.967	4.0	5.0	24.467	3.670	11.978	15.487	3.029	1.550	11.978	105.0	1.03
n-Pentane	C_5H_{12}	72.144	0.1904[a]	5.252[a]	2.4872[a]	4016	3709	21,091	19,517	8.0	30.114	38.114	5.0	6.0	30.114	3.648	11.805	15.453	3.050	1.498	11.805	103.0	1.04
Olefin Series C_nH_{2n}:																							
Ethylene	C_2H_4	28.051	0.07456	13.412	0.9740	1613.8	1513.2	21,644	20,295	3.0	11.293	14.293	2.0	3.0	11.293	3.422	11.385	14.807	3.138	1.285	11.385	105.0	1.00
Propylene	C_3H_6	42.077	0.1110[a]	9.007[a]	1.4574[a]	2336	2186	21,041	19,691	4.5	16.939	21.439	3.0	4.0	16.939	3.422	11.385	14.807	3.138	1.285	11.385	105.0	1.02
n-Butene (Butylene)	C_4H_8	56.102	0.1480[a]	6.756[a]	1.9336[a]	3084	2885	20,840	19,496	6.0	22.585	28.585	4.0	4.0	22.585	3.422	11.385	14.807	3.138	1.285	11.385	104.0	1.03
Isobutene	C_4H_8	56.102	0.1480[a]	6.756[a]	1.9336[a]	3068	2869	20,730	19,382	6.0	22.585	28.585	4.0	4.0	22.585	3.422	11.385	14.807	3.138	1.285	11.385	104.0	1.03
n-Pentene	C_5H_{10}	70.128	0.1853[a]	5.400[a]	2.4180[a]	3836	3586	20,712	19,363	7.5	28.232	35.732	5.0	5.0	28.232	3.422	11.385	14.807	3.138	1.285	11.385	104.0	1.04
Aromatic Series C_nH_{2n-6}:																							
Benzene	C_6H_6	78.107	0.2060[a]	4.852[a]	2.6920[a]	3751	3601	18,210	17,480	7.5	28.232	35.732	6.0	3.0	28.232	3.073	10.224	13.297	3.381	0.692	10.224	102.0	1.05
Toluene	C_7H_8	92.132	0.2431[a]	4.113[a]	3.1760[a]	4484	4284	18,440	17,620	9.0	33.878	42.878	7.0	4.0	33.878	3.126	10.401	13.527	3.344	0.782	10.401	107.0	1.05
Xylene	C_8H_{10}	106.158	0.2803[a]	3.567[a]	3.6618[a]	5230	4990	18,650	17,700	10.5	39.524	50.024	8.0	5.0	39.524	3.165	10.530	13.695	3.317	0.849	10.530	102.0	1.05

* *Adapted from Table 80, Fuel Flue Gases, American Gas Association, 1941.*

All gas volumes corrected to 60° F. and 30" Hg. dry. For gases saturated with water at 60° F., 1.73 percent of the Btu value must be deducted.

[a] Calculated from atomic weights given in *Journal of the American Chemical Society*, February, 1937.

[b] Densities calculated from values given in grams per liter at 0° C. and 760 mm. in the International Critical Tables allowing for the known deviations from the gas laws. Where the coefficient of expansion was not available, the assumed value was taken as 0.0037 per °C. Compare this with 0.003662 which is the coefficient for a perfect gas. Where no densities were available the volume of the mol was taken 22.4116 liters.

[c] Converted to mean Btu per lb. (1/180 of the heat per lb. of water from 32° F. to 212° F.) from data by Frederick D. Rossini, National Bureau of Standards, letter of April 10, 1937, except as noted.

[d] Deduction from gross to net heating value determined by deducting 18,019 Btu per pound mol of water in the products of combustion. Osborne, Stimson, and Ginnings, *Mechanical Engineering*, p. 163, March, 1935, and Osborne, Stimson, and Fiock, National Bureau of Standards Research Paper 200.

[e] Denotes that either the density or the coefficient of expansion has been assumed. Some of the materials cannot exist as gases at 60° F. and 30" Hg. pressure, in which case the values are theoretical ones given for ease of calculation of gas problems. Under the actual concentrations in which these materials are present their partial pressure is low enough to keep them as gases.

[f] From Third Edition of "Combustion."

[g] National Bureau of Standards, RP 1141.

Long luminous flames became associated with tube failures and were therefore avoided by all means, including firing with up to 300 percent excess air. On the other hand, since petroleum heaters are normally designed with a relatively small fraction of the furnace envelope covered with tubes so that the tubes are exposed to appreciable high emissivity reradiation from the furnace refractories, the relatively low emissivity of non-luminous flames normally used in the heaters is compensated by this reradiation which also tends to equalize the radiant-heat transfer rates throughout the heater. Luminous-flame firing could be used with some advantage in large horizontally fired heaters with a large cold fraction where the combustion gases are the main source of heat radiation. The luminous burners would have to be placed far enough from the bridge wall or other obstruction which changes the direction of the free flow of the gases to permit complete combustion of the fuel before the gases reach the obstruction. Otherwise uncontrolled secondary combustion may occur at this point, with the resultant overheating of those tubes which are near the zone of secondary combustion.

The majority of refinery heaters are fired with atmospheric air nonluminous-flame burners. Gas pressures of 5 to 30 psi are used and the energy of the gas is utilized to induce part of the air as primary air in inspirating burners or to provide turbulence in the burner block to mix the gas with the air by impact of high-pressure gas jets upon the surfaces of the block in burners where all of the air used for combustion is mixed with the gas at the point of ignition by some cross flow arrangement of the gas and air streams.

Inspirating Burners

Inspirating burners may be divided into two main groups, multi-jet and single-jet. In multi-jet burners the gas is discharged in a number of relatively small streams into a multiple-hole refractory burner block where the gas is mixed with air injected by the jets and ignited. In single-jet burners a part of the air varying from 50 to 100 percent of the theoretical is injected by a single stream of gas into a venturi type premixing chamber and the mixture is discharged into a single-hole burner block where the secondary air is supplied around the burner nozzle

by the draft in the heater or by the jet effect of the primary air-gas mixture. As a general rule multi-jet burners are of relatively large capacity and only a few are used per heater. The single-jet premix burners are normally of much smaller capacity and as many as 30 are used in some heaters, installed practically side by side to produce a relatively thin, broad, high-velocity stream of combustion gases in the furnace.

this distance. Relatively large amounts of excess air, 50 percent and higher, are used with this type of burner to obtain clear flames. The burners operate best with a high draft on the furnace to permit the use of smaller diameter or longer burner-block openings and to obtain better mixing of the gas with the air. Figure 14b shows an improved variant of the type of burner where the gas jets are introduced tangentialy into the holes of the refractory block to

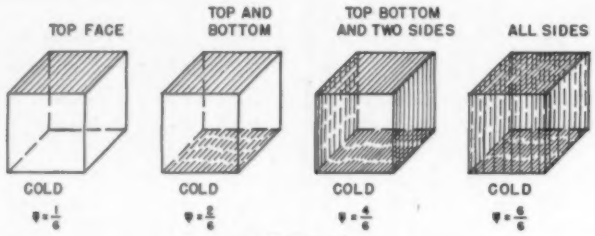


FIGURE 11
Schematic representation of cold fraction as obtained in cubical furnace.

Some types of burners used on petroleum heaters combine partial premixing of the gas with the air in short venturies with multi-jet discharge of the mixture into single-hole or multi-hole burner blocks. These are usually high-capacity burners.

Figures 14 and 15 show four types of multi-jet burners commonly used on petroleum heaters. In the burner on Figure 14 the individual gas jets fire through separate openings in a refractory burner block which act as mixing nozzles for the gas with the air, and as ignition zones for each jet. Usually the holes in the refractory block are shaped to form a short venturi tube and the jets are so positioned with respect to the holes that ignition occurs in the hole just beyond the throat of the venturi. Due to relatively poor mixing of the gas with the air in the short venturies, combustion is completed in the furnace proper usually 2 to 5 feet from the burner block. Relatively high furnace temperatures are maintained just beyond the block by recessing the burners in the wall or by ignition arches to assist combustion within

facilitate ignition and obtain good combustion with somewhat lower amount of excess air.

Figure 15a shows a barrel-type partially premixing multi-jet burner. Jets of a rich gas-air mixture discharge along the outer circumference of the face of the barrel at an angle with the center line of the barrel into the main air stream. The air stream is given a rotary motion by fixed blades on the plate of the air register of the burner. Normally a relatively deep (9-15 inches) cylindrical burner block is used and the end of the burner barrel is so positioned in the block that the gas jets impinge upon the surfaces of the block, 3 to 5 inches from the outer edge of the block. Ignition starts near the points of impingement and maintains the block very hot from these points to the edge. High turbulence produced by impingement and by ignition assists the mixing of the gas with the air within the burner block, and the hot refractory surface aids to complete ignition before the gas-air mixture leaves the block. Combustion is normally completed a short distance beyond

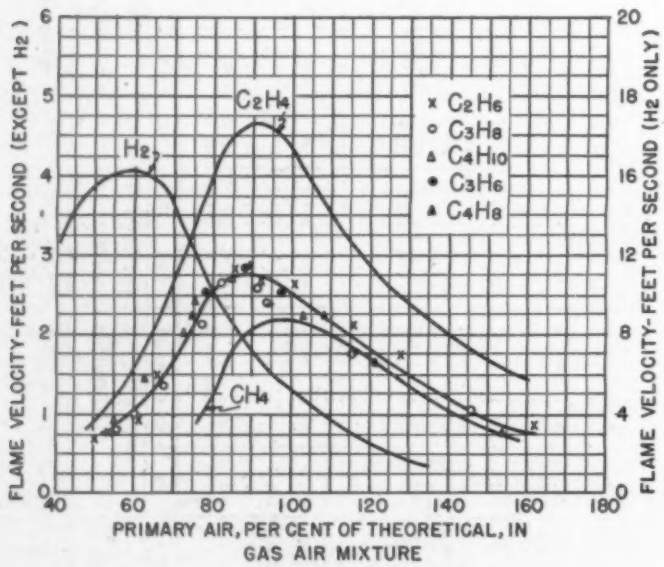


FIGURE 12
Velocity of flame propagation of constituents of refinery fuels as function of the air used in gas-air mixture.

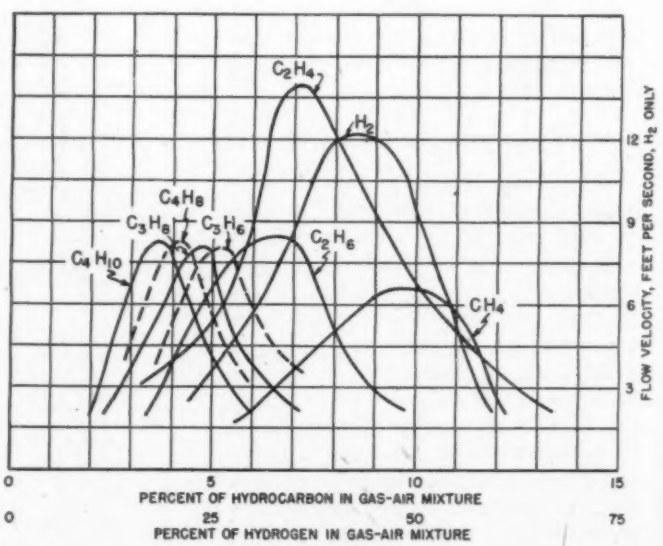


FIGURE 13
Velocity of flame propagation of refinery fuels as function of percent of combustible in gas-air mixture.

the burner block. The gas-air jets leaving the burner barrel have no induction action. If anything, because of their direction they somewhat obstruct the flow of air through the block so that even with the relatively large cross section of the burner-block opening normally used with this type of burner, appreci-

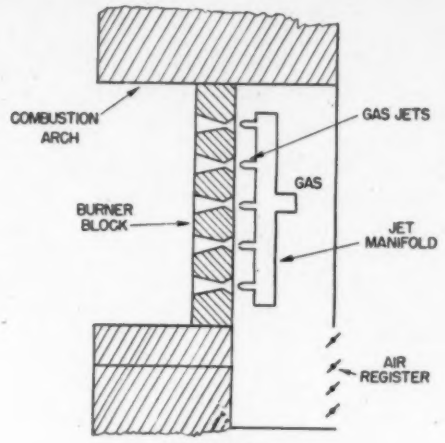
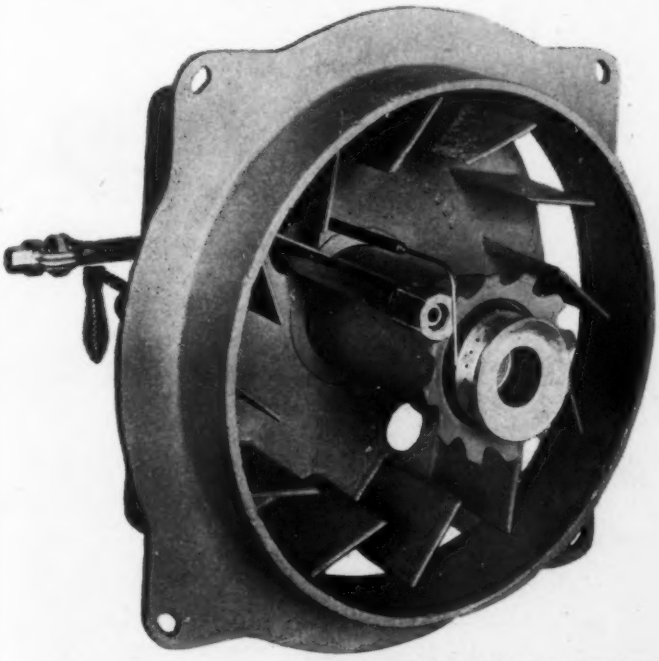


FIGURE 14a
Multi-jet inspirating burner.

able furnace draft or a forced-draft air fan is required to supply the air for combustion. Figure 15b shows a partially premixing burner with a spider head.

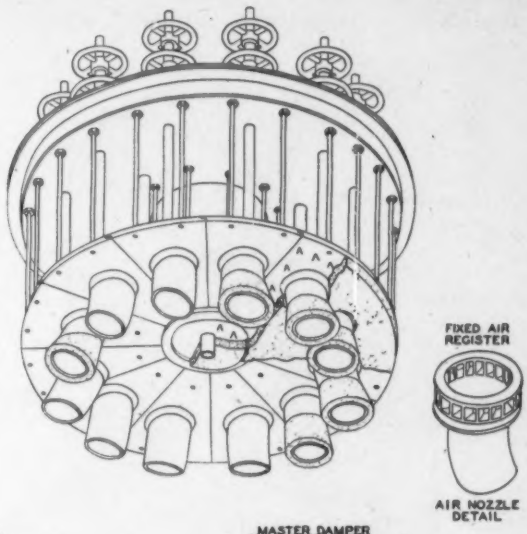
The burners on Figures 14 and 15 are easily adapted to preheated air.

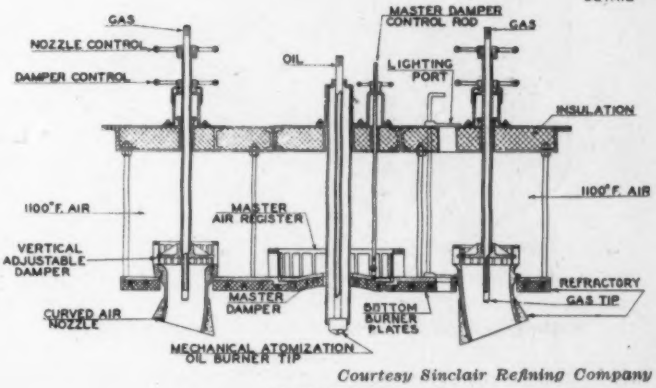
Figure 16 shows a modification of a multi-jet burner particularly suitable for burning large quantities (15-50 million Btu per hour) per burner with air preheated up to 1200° F. A portion of the total



Courtesy Webster Engineering Company
FIGURE 15a

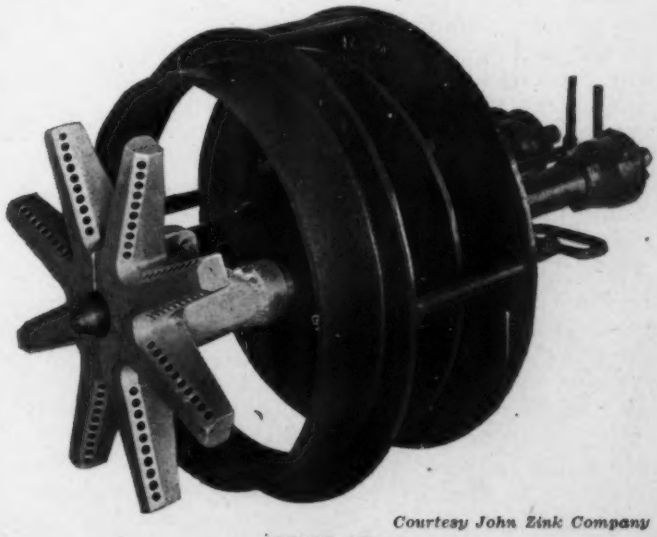
air which is supplied under forced draft into the wind box of the burner is forced through special curved air nozzles around the individual gas jets. The purpose of the nozzles is to premix the gas with some primary air and to direct the primary air-gas mixture across the main stream of the air towards the refractory surface of the block. The nozzles can be rotated to vary the angle of impact of the primary air-gas mixture with the burner-block surface and the exit velocity of the stream of products of combustion leaving the burner block. With the nozzles discharging the primary air-gas mixture along the





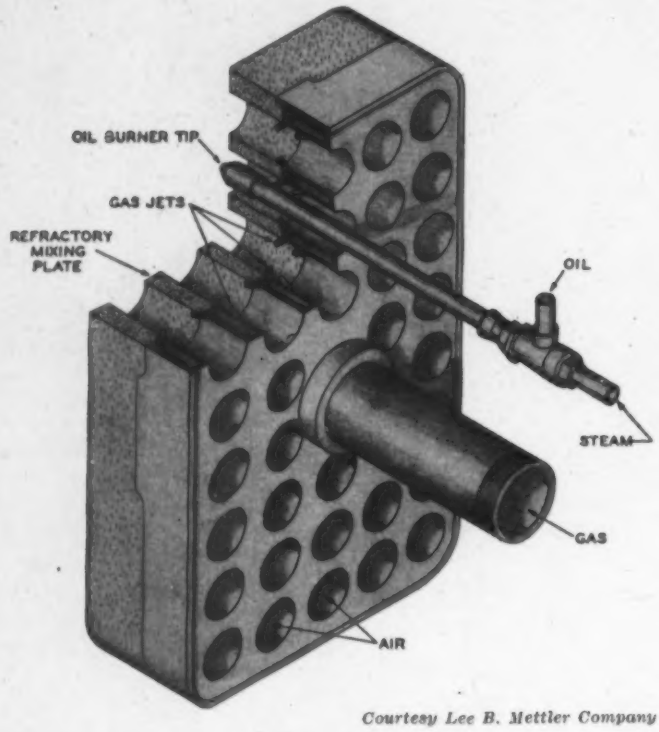
Courtesy Sinclair Refining Company
FIGURE 14b

radii of the hole in the burner block, maximum impact of the gas-air mixture upon the surfaces of the block, best mixing with the secondary air and the lowest burner "muzzle" velocity are obtained. When the nozzles are set to discharge substantially tangentially to the hole in the burner block, the impact and intimacy of mixing of the gas with the total are re-



Courtesy John Zink Company
FIGURE 15b

duced and the product of combustion leave the burner block at a sufficiently high velocity to permit directing the stream of combustion products for as much as 30 feet of their travel. The burner was specially designed for top firing of cylindrical furnaces with vertical tubes to permit control of heat input to segments affected by each burner, but is applicable to large conventional "box-type" furnaces,



Courtesy Lee B. Mettler Company

FIGURE 16
Multi-jet inspirating for forced-draft highly-preheated air.

particularly where controllable different rates of heat input to different sections of the tube bank are desirable, and could be obtained by controlling the flow of the products of combustion from individual burners.

Figure 17 shows a single-jet venturi-inspirating premix burner of a type used on a large number of oil heaters of various types. In this burner the air is injected into the venturi by a single stream of gas discharged through an orifice under sufficient pressure to induce between 75 and 100 percent of the theoretical air required for combustion. The remainder of the air to give a total of 25-50 percent excess over the theoretical is supplied as secondary air through the burner block around the tip of the burner by the jet action of the primary stream or by the draft in the heater. Generally round tips, as shown in Figure 17a, are used with the burners to give a cone-shaped flame. Flat fan-shaped flames can be obtained with this burner by the use of special nozzles as shown in Figure 17b.

The performance of the venturi inspirating burners is determined by the rate of induction of primary air by the gas stream and the pressure developed by the gas-primary air mixture in the burner nozzle which in turn are determined by the shape of venturi tube used as the mixer. Figure 18 shows capacities of inspirating burners with venturies of approximately theoretical shape when burning different gases at different pressures and inducing approximately 100 percent of the theoretical air as primary. The charts in the figure are based on the assumption that the theoretical gas-air mixture of any gas has a gross calorific value of 100 Btu per cubic feet and a specific gravity of 1.0. The capacity of the spud is determined from the relationship

$$F_s = \sqrt{0.6/g} \times 100C$$

and the capacity of the inspirator from the relationship

$$F_i = \sqrt{g/0.6} \times 10^{11}/C^2,$$

where g is the specific gravity of the gas (air = 1) and C is the gross calorific value, Btu per cubic foot. The formulae were developed by one of the burner manufacturers from calculations of energy and inertia balances of a theoretical venturi, and a large number of actual tests by a public utility during the period of conversion of its territory from a manufactured gas to a blend of manufactured and natural gas. Natural gas with a specific gravity of 0.6 and a calorific value of 1000 Btu per cubic foot was used as the reference fuel, which accounts for the 0.6 value in the square-root portion of the formulae.

The use of the chart can be demonstrated by this example. A mixed gas with a specific gravity of 0.88 and a calorific value of 1500 Btu per cubic foot is to be burned at the rate of 1000 cubic feet per hour per burner.

a. What spud size is required with 20 psig gas pressure at the spud?

b. Will the burner be suitable for burning natural gas of 1000 Btu and 0.6 specific gravity if natural gas is available at pressure up to 50 psig?

One thousand cubic feet of 1500-Btu gas have a total Btu content of 1.5 million or 1500 thousands. The intersection of the 1500 ordinate with the 20 pounds inclined line projected to the scale of 1533 Btu 0.883 specific gravity gas gives 12/64 for the hole

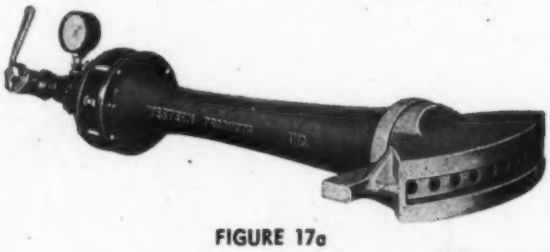
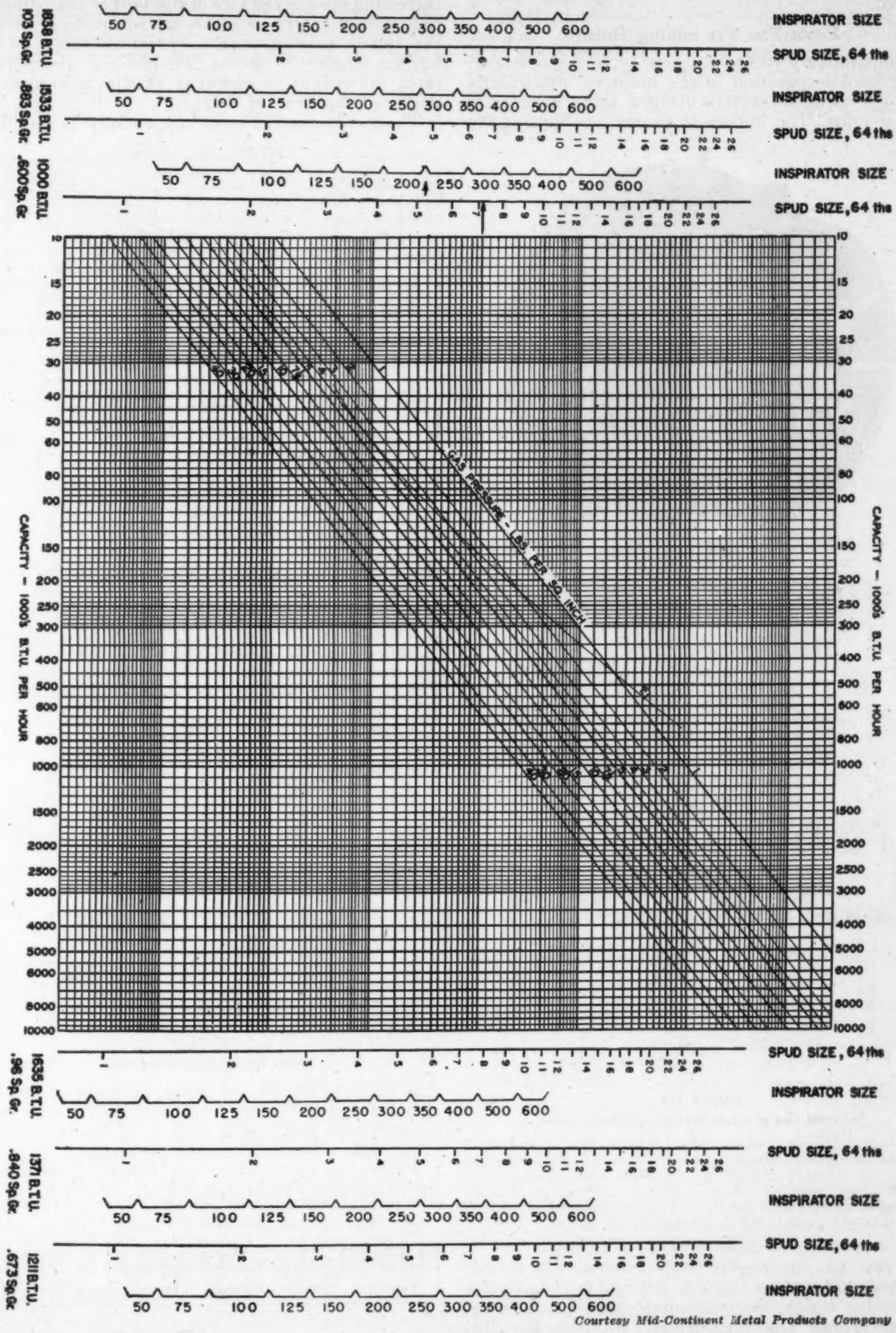


FIGURE 17a

Courtesy Western Products Company

FIGURE 17b
Single-jet venturi inspirating burners.

in the spud and a No. 600 or 6-inch inspirator. Project the 12/64 on spud size point to the scale for the natural gas until it intersects the 1500 ordinate. The answer is 31 pounds. Since natural gas at pressures up to 50 pounds is available, the burner spud will handle the natural gas. The inspirator size corresponding to the 12/64 spud for natural gas is No. 500 or 5-inch. The air register on the burner will have to be shut down somewhat to prevent the induction of too much air as primary air. The values shown on the chart can be applied with good accuracy for gases other than those shown by using the scale of a gas



Courtesy Mid-Continent Metal Products Company

FIGURE 18
Capacities of single-jet inspirating burners.

varying not more than ± 75 Btu from the gas considered.

Rotor-Fan Pre-mixing Burner

Comparatively recently a new type of gas burner has gained recognition in the industry, particularly for large-capacity heaters using a small number of burner units. The burner is shown on Figures 19a and 19b. In this burner high-pressure gas is discharged through openings in a set of hollow spokes of a rotor which operates on the principle of a reaction turbine. The rotor drives a propeller installed back of the rotor. The propeller acts as a forced-draft fan for the air required for combustion. The gas holes in the rotor and the pitch of the propeller are so correlated for a given size of the burner that substantially constant gas-air ratios are maintained through the major portion of the operating range of the burner. Figure 20 shows the gas and air delivery rates at various percentages of the maximum capacity of this type of burner.

Courtesy Coppus Engineering Corporation

FIGURE 19a

Rotary-blade forced-draft burner.

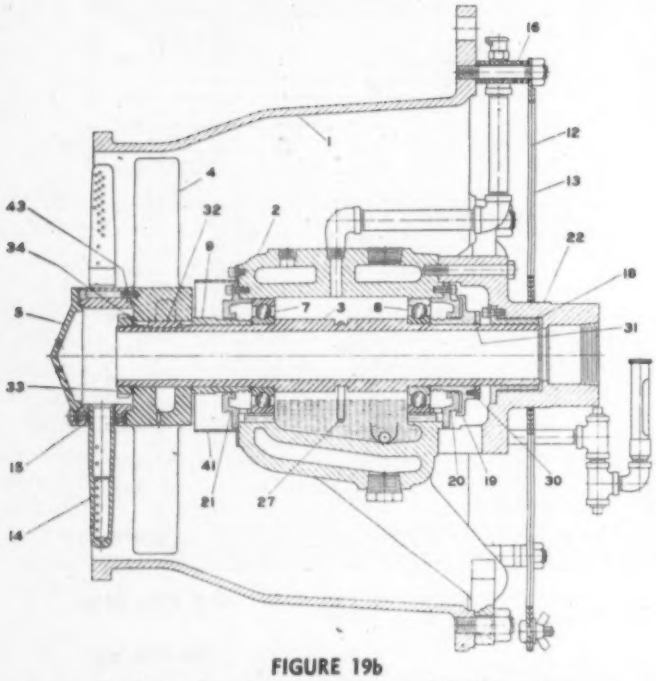


FIGURE 19b

Sectional view of rotary blade forced-draft burner.

1 Casing; 2 Spider; 3 shaft; 4 fan; 5 nose plate; 7 front ball bearing; 8 rear ball bearing; 9 shaft sleeve; 12 shutter frame; 13 shutter slide; 14 driver arm; 15 driver hub; 16 spacer; 18 labyrinth bushing; 19 deflector; 20 rear enclosure; 21 front enclosure; 22 inlet housing; 27 oil ring; 33 lock nut; 41 shield; 43 gasket; 44 gasket; 70 filter-breather.

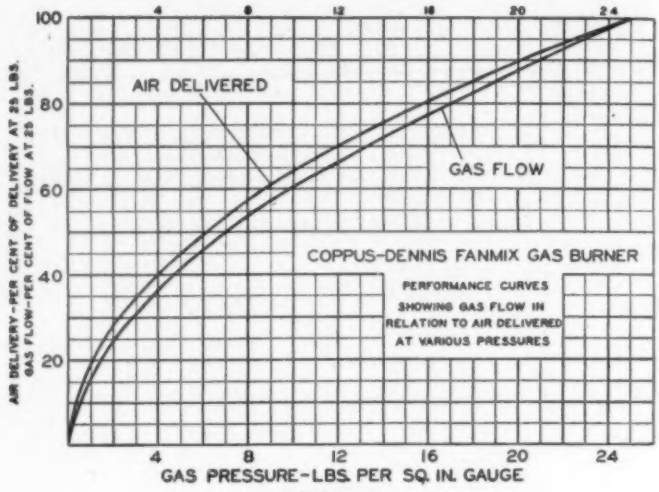


FIGURE 20

Gas and air delivery rates of burner on Figure 19.

tion of rotation and the gas jets enter the air stream practically at right angles with the stream. Very thorough and instantaneous mixing between the gas and the air is obtained, and relatively small amounts of excess air, 5-15 percent over the theoretical, can be used to obtain perfect short-flame combustion. The refractory burner block is usually so arranged that the rotating stream of the products of combustion leaving the burner fans out into a very wide cone (up to 150°) with very little forward motion of the gases due to inertia of the stream.

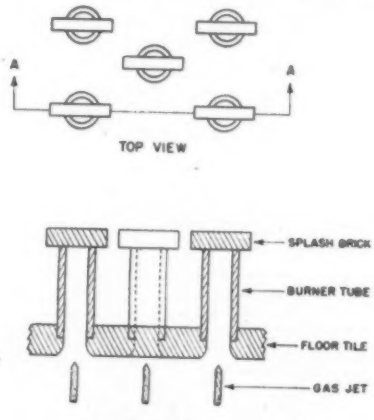
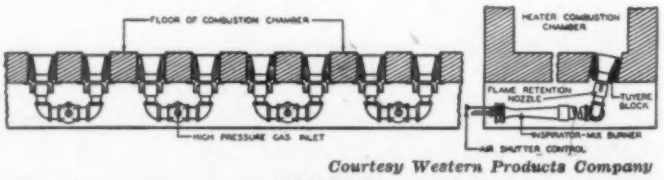


FIGURE 21

Floor burner, tube mixing type.

Figures 21 and 22 show two types of floor burners for firing along the major portion of the floor area



Courtesy Western Products Company

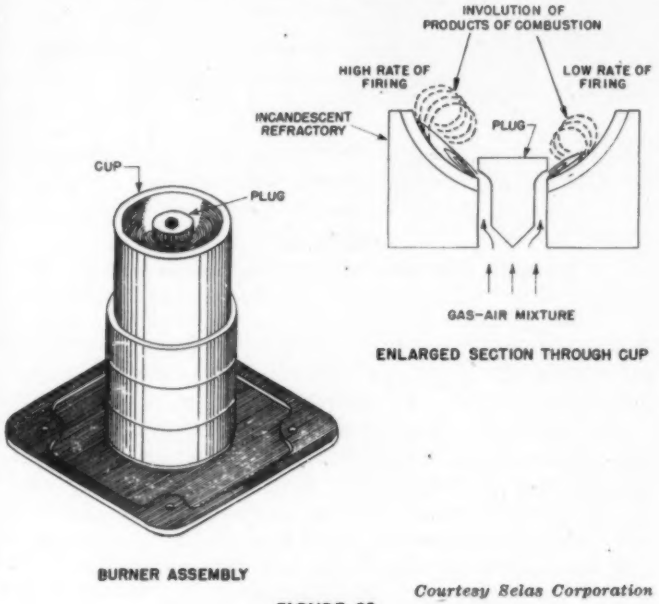
FIGURE 22

Floor burner, single-jet inspirating type.

of a heater. Figure 21 shows the earlier type of a floor burner where long cylindrical refractory tubes are used for mixing and igniting the fuel. Special refractory shapes are placed across the outlet of the tubes to create turbulence and to improve mixing and ignition in the tubes. Figure 22 shows an adaptation of a venturi inspirating burner to floor firing which is displacing the older type.

"Flameless" Burner

Figure 23 shows a "flameless" type of burner quite extensively used in a number of industries and considered at present for use in refinery heaters. The burner can be used advantageously in conventional heaters, particularly those with roof and side-wall tubes, as a floor burner or as an end burner, and is particularly well suited for cell-type heaters where the tube banks are placed between the walls of the



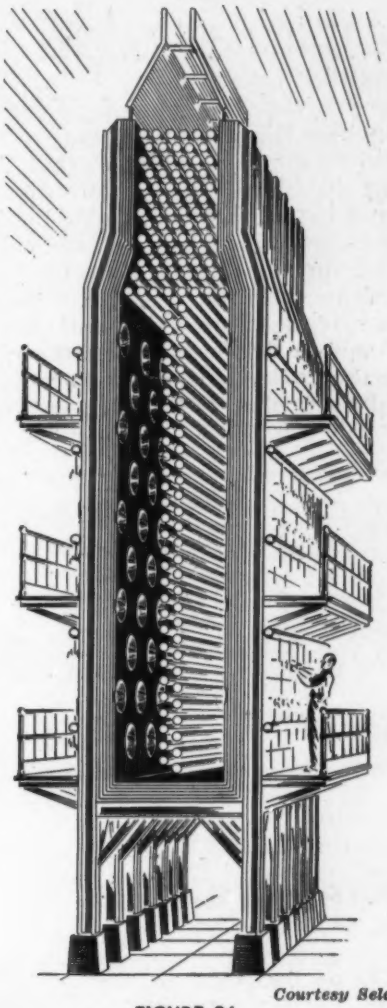
Courtesy Selas Corporation

FIGURE 23
"Flameless" gas burner.

cell which act as the main source of radiant-heat energy to the banks. The burner is of the sealed-in type and all of the air used for combustion is premixed with the gas before ignition. The gas-air mixture is made to impinge upon a cup-like refractory surface of a combination burner tip and burner block and to sweep the surface from the center to the periphery. The burners are usually placed side by side. The gas streams leaving the individual cups impinge upon each other and the resultant eddies dissipate the tangential velocity of the gases leaving the cups so that a relatively quiescent stream of gases from the burners into the furnace chamber is obtained, permitting placing the tubes close to the burners. The refractories of the cups are at close to white heat and act as high-temperature, high-emissivity radiant-heat sources. The individual burners can be manifolded in groups which could be separately controlled to give any desired heat distribution along a heat-absorbing plane facing the burners. Figure 24 shows a proposed application of the burner to refinery heaters.

Refinery Gas Fuel Systems

Refinery heaters operate at constant load and with constant furnace and transfer temperatures. In many processes variation over ± 5° F. in the transfer temperature may seriously affect the yield and quality of the principal product and particularly of the gas. Since most refinery heaters usually are fired with the gas produced by the unit of which they are a part, fluctuations in the rate of firing of the heater due to variation in the pressure of the gas header or the quality of the gas become accumulative and, if not corrected, may bring the unit off stream or coke up the heater. It is therefore very important to maintain the quantity and the quality of the gas supplied



Courtesy Selas Corporation

FIGURE 24
Proposed applications of flameless burners to refinery heaters.

to the heater as constant as possible and to provide means to compensate for the normal variations in the quantity and quality of the gas, and particularly for the temporary upsets due to misoperation.

If a heater is one of a group fired as a battery from a single fuel system to which the battery supplies fuel gas in excess of the fuel requirements of the battery, a balance tank into which all units discharge the gas before it is distributed may be sufficient to take care of the variations from the individual units. The tank is maintained at a pressure below that in the gas section of the lowest-pressure unit, but 10-15 psig higher than the header pressure on the burners on any of the heaters to permit releasing the excess gas from the battery to fuel-consuming units outside the battery. The system can be arranged to selectively release the excess to more than one outside system or to supply gas to the various units within the battery according to a set priority, as

shown on Figure 25 for a three-step system. If a heater is one of a group fired as a battery where the gas produced is not sufficient to meet the requirements of all heaters, gas from outside of the battery, such as natural gas, refinery gas from other units, or liquid C_3 and C_4, have to be admitted continuously and automatically into the tank if all units of the battery are to be fired with gas. This is shown in dotted lines on the figure. If no outside gas is available, the gas supply to the heaters within the battery will have to be so arranged that the heaters on units most susceptible to changes in firing get first call on the available gas and become the first priority units of the system, as shown on Figure 25.

On heaters fired by automatic controls from a gas system where refinery gases are augmented by natural gas and where the ratio of refinery to natural gas varies within rather wide limits so that the calorific value of the blend fluctuates more than the permissible variation of heat input to the heaters, it may be necessary to control the calorific value of the gas by admitting C_3 and C_4 into the balance tank of the system in such amounts that a blend of these hydrocarbons with natural gas will have approximately the same calorific value as the normal final blend from the tank. This can be accomplished by proportional flow meters on the natural-gas and hydrocarbon lines to the tank or by a controlling calorimeter on the final gas which regulates the flow of the C_3 or C_4 into the system to keep the Btu of the final gas constant. Where there is more than one fuel system the same results may be accomplished by rearranging the grouping of the heaters for a better balance of the gas supply and demand, particularly if the units are closely spaced and the cost of rearranging the process area fuel-gas piping is not excessive.

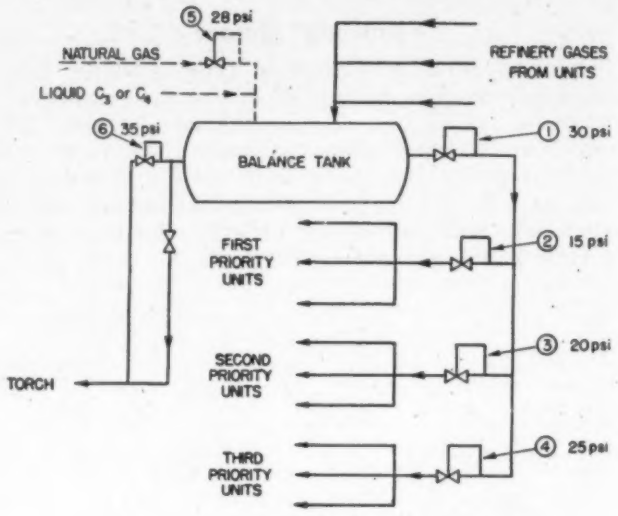


FIGURE 25

Schematic arrangement of a refinery fuel gas system.

Formulae:

Calorific value, gross, Btu./cu. ft.

$$C_{vg} = 215 + 1500g$$

g = Sp. Gravity of gas (Air = 1)

Calorific value, net, Btu./cu. ft.

$$C_{vn} = C_{vg} - (60 + 75g)$$
$$155 + 1425g$$

Theoretical air requirements

$$A_v = 1.15 + 15g \text{ cu. ft./cu. ft. of gas}$$
$$A_m = 15 + \frac{1.15}{g} \text{ lbs./lbs. of gas}$$

Hydrogen content, fraction by wt.

$$H = 0.188 + \frac{0.05\,(1 - g^2)}{g}$$

Mols of H_2O per lbs. of gas

$$M_w = \frac{H}{2}$$

Mols of CO_2 per lbs. of gas

$$M_c = \frac{1 - H}{12}$$

Air used for combustion, mols./lbs. of gas

$$M_a = (1 + E)\,\frac{2H + 1}{2.52}$$

E = excess air used

Total combustion products, wet, mols/lbs. of gas

$$M_{pw} = (0.79 + E)\left(\frac{2H + 1}{2.52}\right) + \frac{1 + 5H}{12}$$

Combustion products, dry, mols/lbs. of gas

$$M_{pd} = (0.79 + E)\left(\frac{2H + 1}{2.52}\right) + \frac{1 - H}{12}$$

Sensible heat, Btu per mol of products

$$Q_v = \frac{379C_{vn} + Q_1M_a}{M_{pw}}$$

Sensible heat, Btu. per lb. of products

$$Q_m = \frac{379C_{vn} + Q_1M_a}{28.9M_{pw} \times g}$$

379 = cu. ft./mol.

28.9 = mol. wt. of air

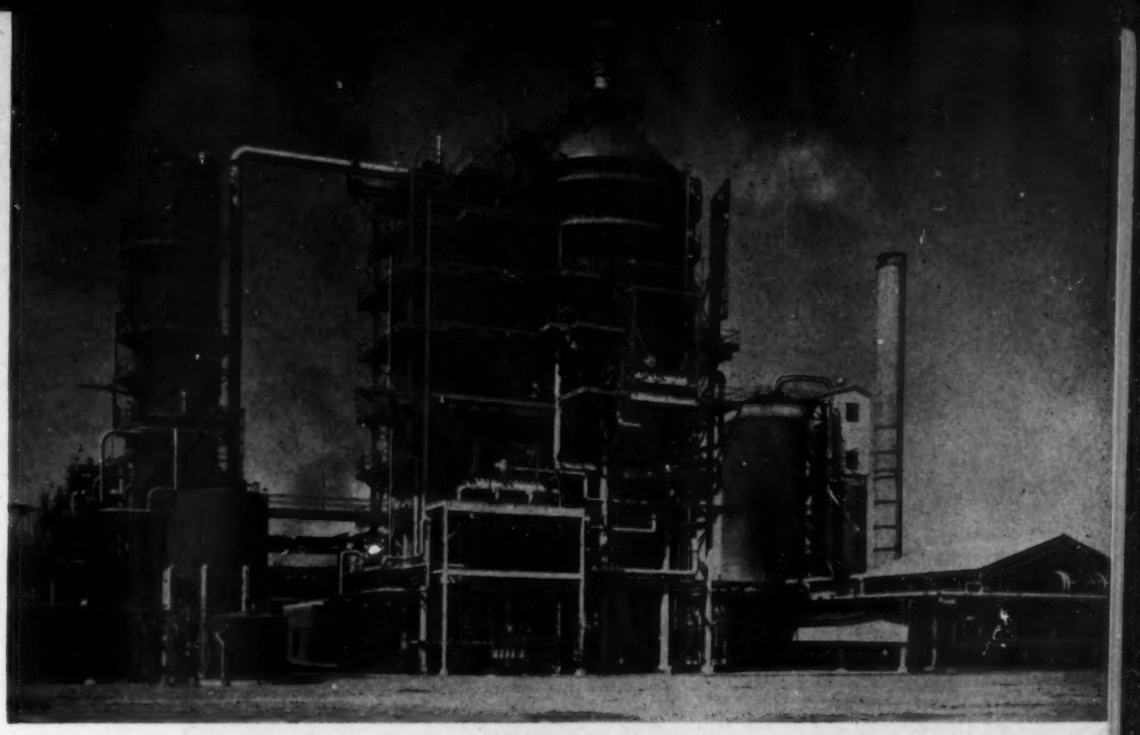
Q_1 = heat content of air above 60° F., Btu./mol.

g = sp. gr. of products (wet)

The various types of modern refinery heaters and the gas-burning equipment as used on the well-established processes of present-day oil refining such as destillation and thermal and catalytic cracking are, as a general rule, well suited for the purpose and represent important steps in the progress of the art of heat generation and application to meet the rather exacting requirements of these processes. But it is characteristic of the industry not to be satisfied for very long with a *status quo* of either the processes or the equipment. The development of some of the chemical processes in which petroleum products are the raw materials indicates that heaters of totally different types from those considered standard at present may be required, and that the control of heat application in these heaters may be much more critical than in the best existing type. Fortunately, other industries, particularly that of metal manufacturing and fabrication, have developed a wide variety of specialized furnaces, fired with manufactured gas or blends of manufactured and natural gas, which can be modified for use on the new refining processes with refinery gases as fuel. The problem of adapting these heaters may not be how to fire them with refinery gases, but, what with the constantly decreasing supplies of the gases and increasing demands for them as fuels and as raw materials, where to find refinery gases to fire the heaters.

Acknowledgment

The authors wish to express their thanks to the refining companies which supplied the data on the gas fuels burned in their refineries, and to Universal Oil Products Company for the use of its Engineering Curves as a pattern in the preparation of Figures 3 and 6 of the article.



Main Structure

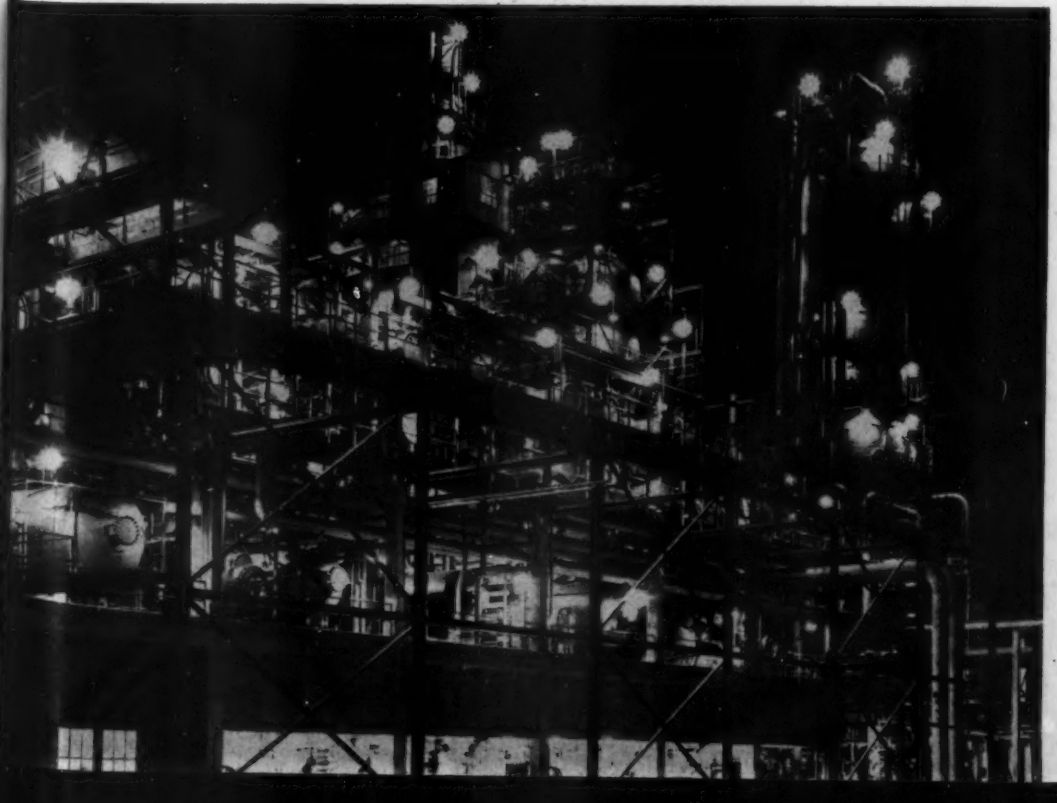
Regenerator has a short stack through which flue gases are vented. Fractionator is at left with catalyst slurry settling tank immediately in front. The reactor is at left of regenerator. Reactor vapor line to fractionator has been made smaller by utilization of maximum practical pressure drop. Smaller line does not require complex bends for expansion.

Shell Incorporates Design Refinements In Fluid Catalytic Unit at Deer Park

L. S. DANIELS, Associate Editor

SHELL Oil Company's new "fluid" type catalytic cracking unit at its Deer Park (Houston) refinery incorporates much of the experience gained in the operation of earlier fluid units, as well as a number of newly developed design features undergoing initial commercial application. The unit is of special interest because it is the first large-scale plant placed in operation which has been designed for use with "micro-sphere" cracking catalyst. At present, results with this catalyst are not available as initial operation has been with ground catalyst. Also of considerable interest are refinements in the process design of the unit, and in the details of the process equipment, instrument installation, piping design, and equipment layout. Using pressure-drop data gained on previous units, and through careful design of the catalyst-circulation system, it has been possible to lower the elevation of the regenerator, and considerably reduce the overall height of the unit.

The physical layout of the unit is noteworthy. Process equipment is provided with suitable access

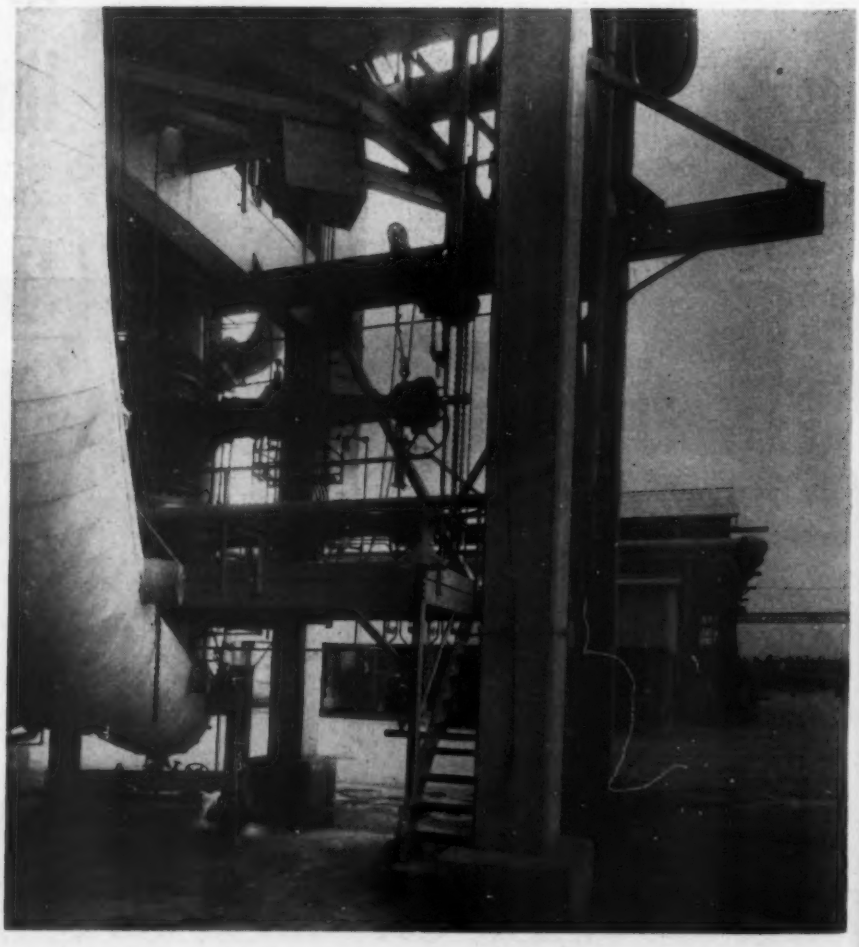


Equipment Support

Structure has three decks, with exchangers and coolers on highest level, reflux drums and other accumulators at mid-level, and pumps, blowers and compressors at grade level.

Main Catalyst Section

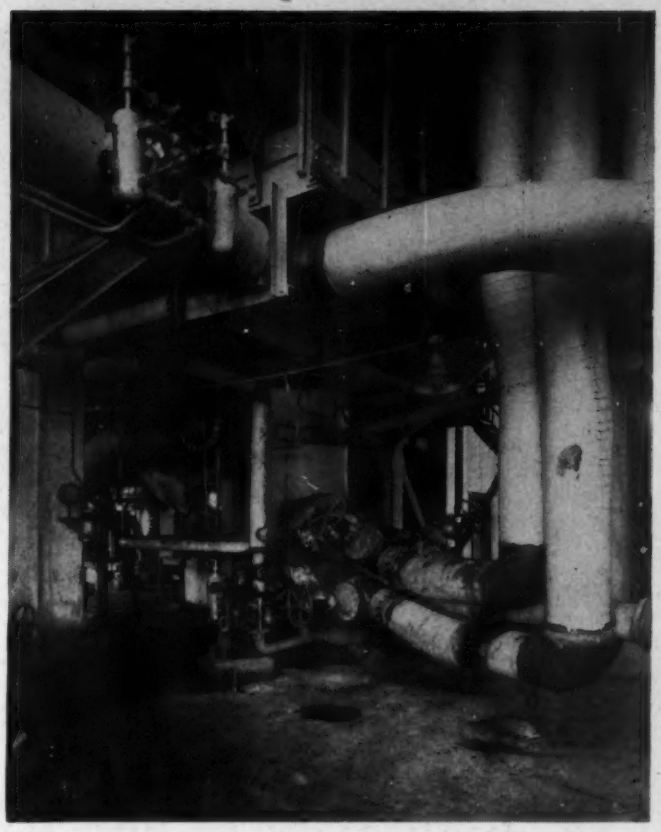
A special crane is installed at corner of main catalyst section for handling process equipment parts and tools required for maintenance or inspection operations.



Typical Slide Valve

Installation has special access platforms and trolleys for handling valve replacements and other maintenance operations.

platforms, trolley beams, and cranes for convenience of operation and for easy maintenance. Equipment is installed with ample clearances which have largely been achieved by careful planning and layout, as the overall plot area of the unit is less than was used for many earlier units of smaller capacity. A special support structure, auxiliary to the main catalyst-section structure, has three floor levels, with exchangers and coolers on the upper deck, surge drums and reflux drums on the center level, and main air blowers and process pumps on the ground level. The compressor house is of novel design compared with usual refinery practice. Individual compressor foundations have been extended to an elevation some feet above grade and the operating floor also elevated to the normal location with relation to the compressors. Compressor suction and discharge piping is installed in the space below the operating floor, and above grade, together with utility piping serving the compressor gas engine drivers. Because of the large sizes of the piping, main suction and discharge lines extend outside the building limits and have been looped around the building walls in alleys above grade level. Access to the compressor operating floor is by means of several short stairways and platform bridges which span the piping alleys. This design greatly simplifies the problems of piping layout and provision for thermal expansion, and eliminates the low spots which require draining and allow gases to accumulate when conventional pipe-trench designs are used.



Operating Floor

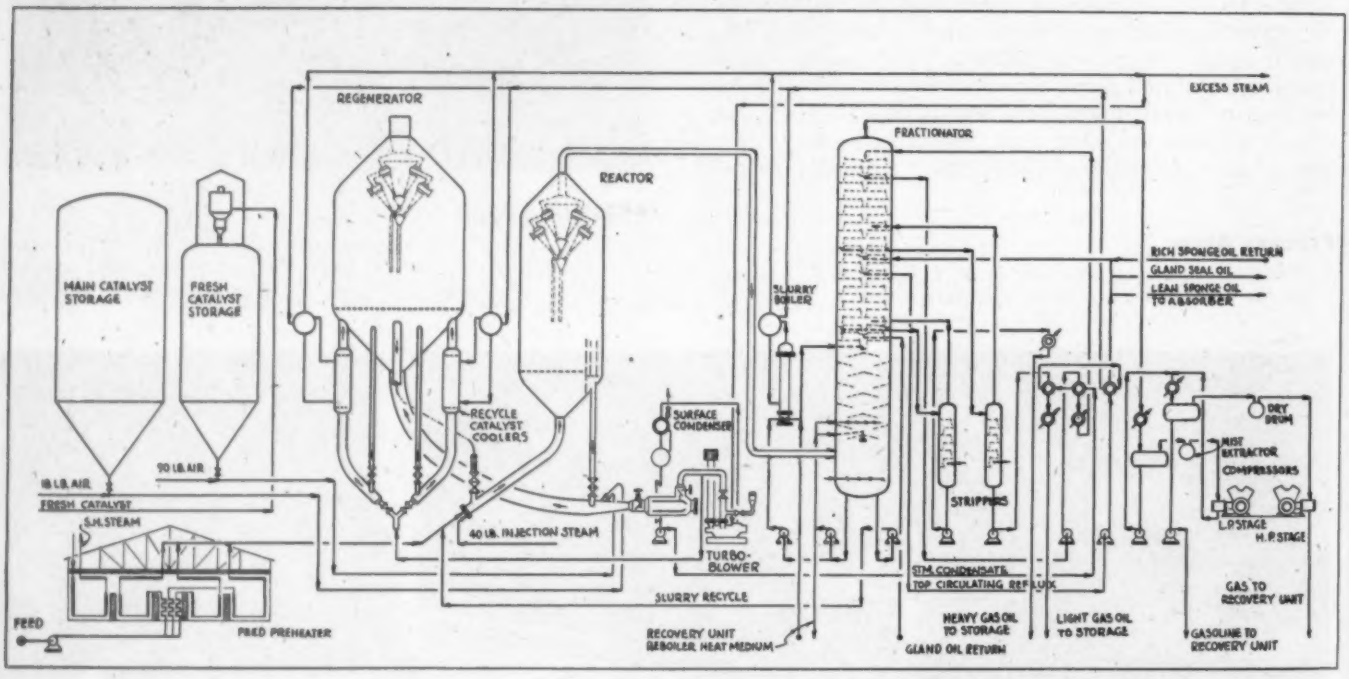
At grade level below regenerator, where fresh oil feed is injected into the catalyst-circulating system. Regenerated catalyst slide valves are located above the small operating platform, and are served by special trolleys,

Process Area

Process equipment structure in background with access way to the process area to be seen in foreground.

Cracking Control Room

Wall opposite control panels is glass, and affords operators an unobstructed view of the regenerator-reactor process area. Control room is in an air-conditioned building which also houses an office for the unit supervisor and a laboratory for routine control tests.



Simplified Flow Diagram

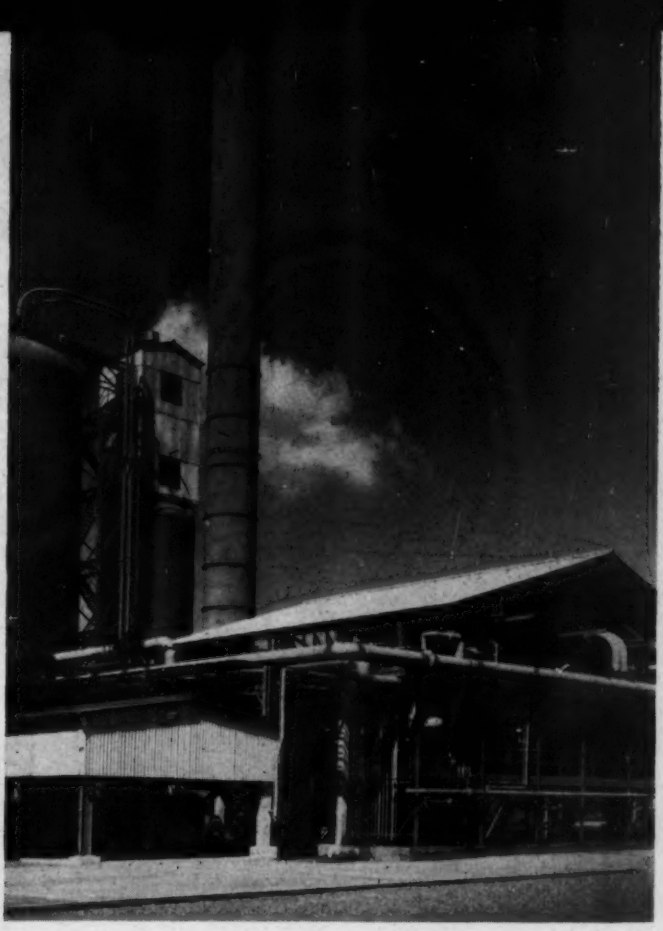
Cracking process.

Control Room

Light-hydrocarbon-recovery.

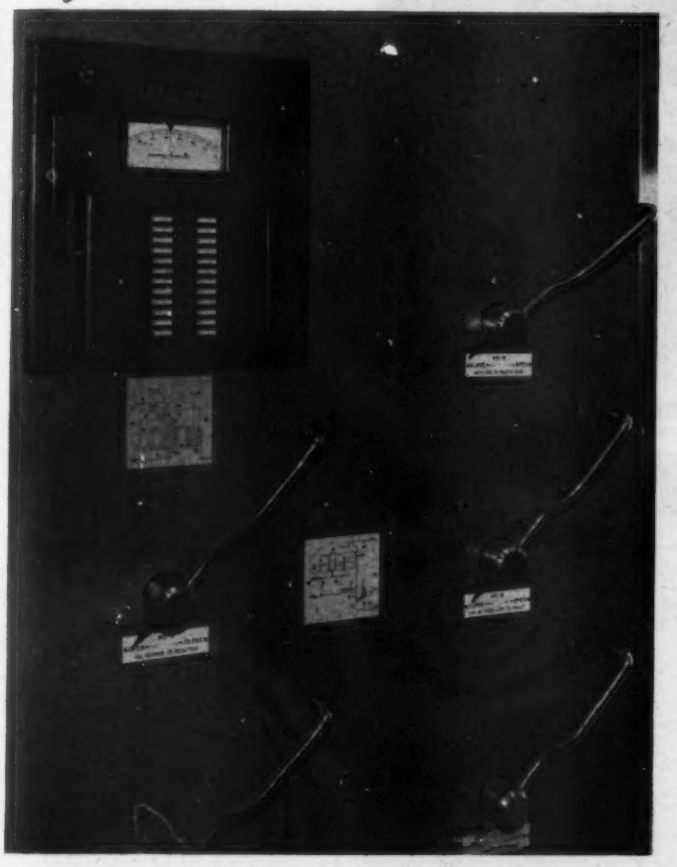
Control of the unit is automatic, with instruments located in a central control house which is air conditioned. The control house is provided with operating desks topped with displays of the unit flow sheets. Various small sections of the flow sheet, engraved on white plastic, are mounted on the instrument panels to illustrate the function of individual instruments and to show the location with relation to process equipment of thermocouples and control points. A small "process-control laboratory" is installed in the instrument control house for convenience in making routine operating control tests.

An inspection of the flow sheet shows the basic design to be similar to that used for earlier "down-flow" type units. Principal process equipment variation is the modified catalyst-recovery system. The electrical precipitator usually installed for the removal of catalyst dust from regenerator flue gases has been omitted, and high-efficiency two-stage cyclone separators have been substituted for the single-stage separators formerly used at the regenerator outlet. It is believed that these new separators alone will be adequate for the recovery of catalyst fines when the unit is operated with the micro-sphere catalyst for which it is designed. Initial and present operation has been with a batch of used ground synthetic catalyst which was available from other fluid units. Losses of this catalyst have been low, and it is believed demonstrated that substitution of the micro-sphere catalyst at the completion of the initial run will result in operation with very satisfactory catalyst



Feed Preheating Furnace

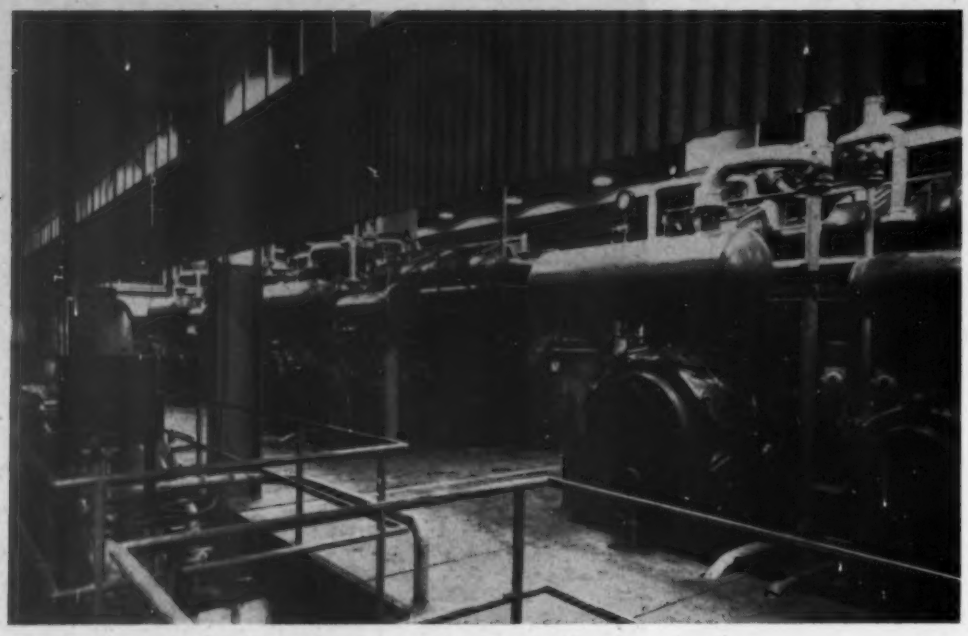
Inert-gas generator in foreground. Inert gas is used as a purge for clearing large vessels of air in start-up operations.



Control-Panel Detail

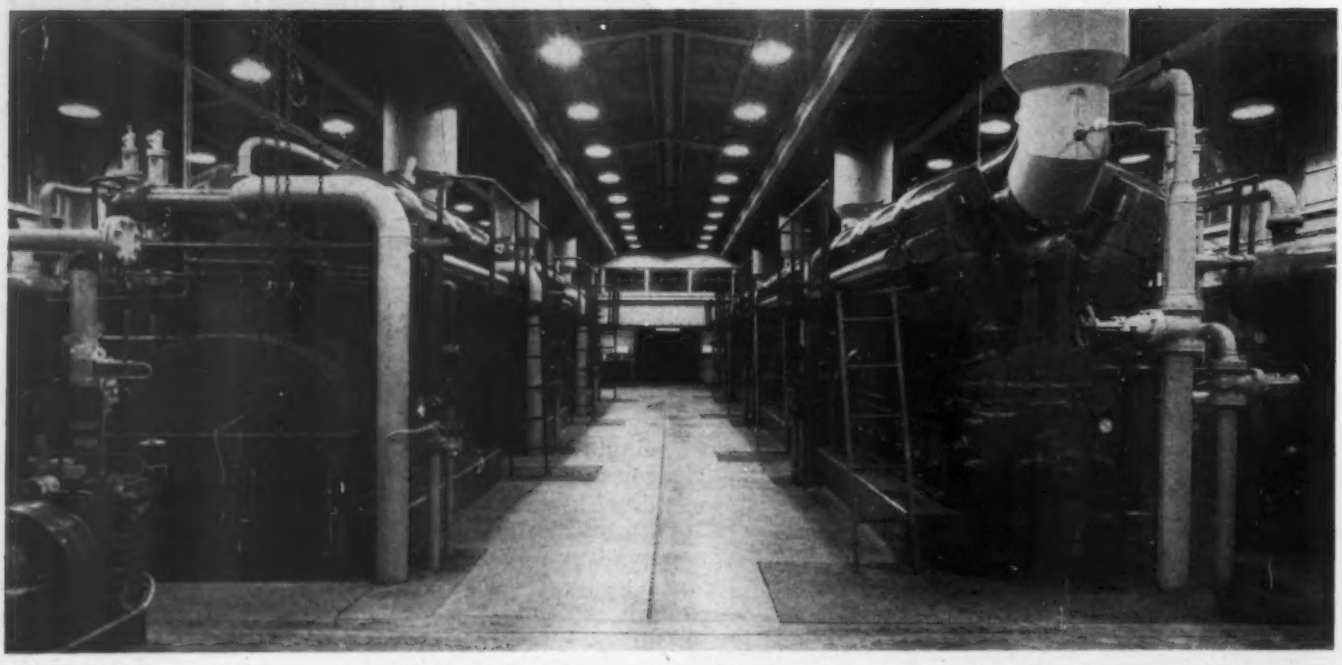
Small diagram below instrument shows location of furnace thermocouple points corresponding to numbered switches of potentiometer. Second diagram indicates position of remotely controlled emergency valves operated by handles on control board.

Process Control Laboratory



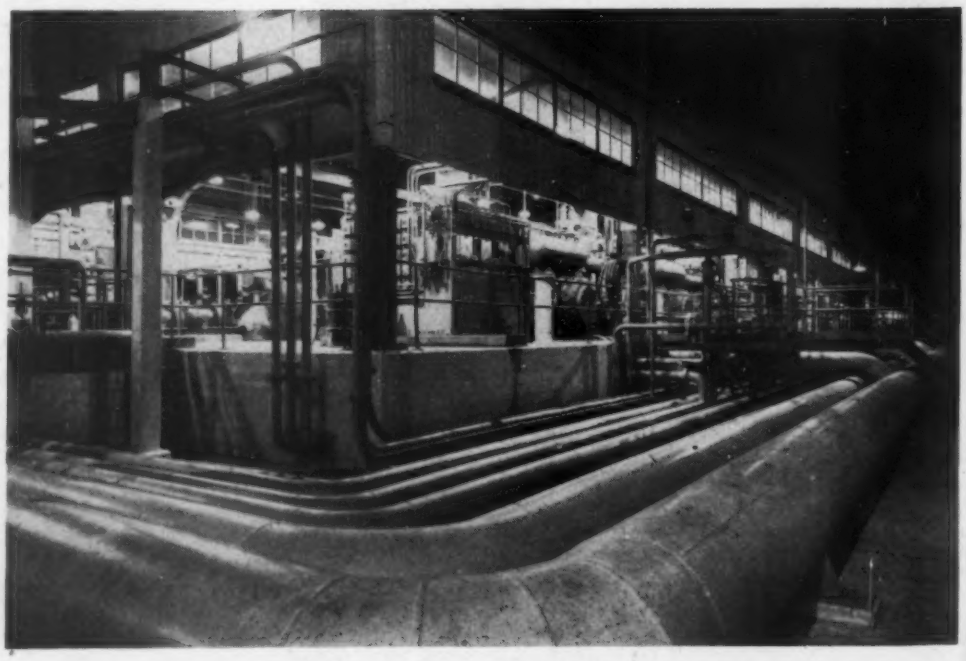
Compressor Room

Compressor cylinder side of several of the gas-engine-driven light-hydrocarbon compressors. Piping is located below the operating floor level. Mild climate makes open type curtain walls of building practical.



Interior

The building has a single open span roof and all cylinders and compressor parts can be handled readily for maintenance operations by overhead trolley and hoist arrangements.

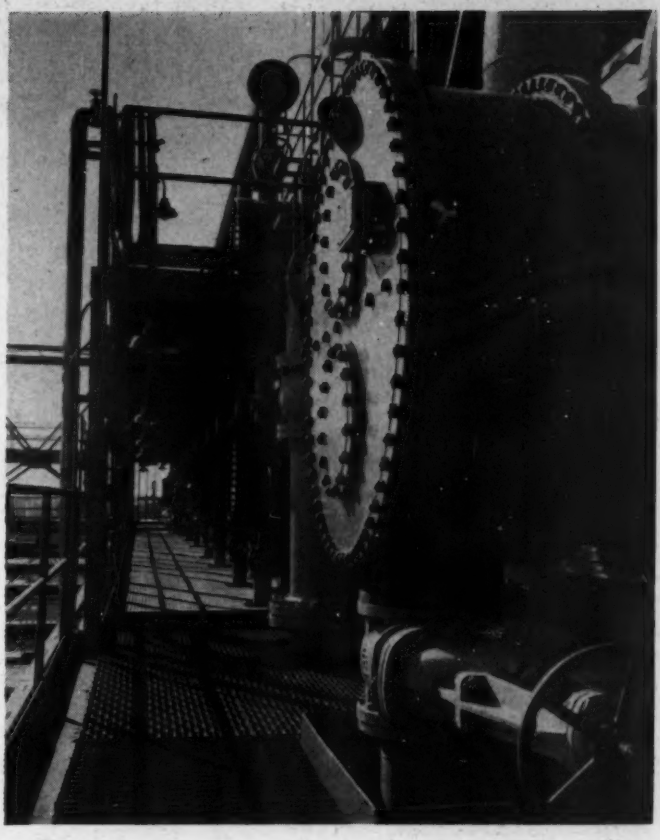


Exterior

Suction and discharge piping to compressors is located above grade, avoiding low spots requiring draining and trenches which also would need draining and which are hazardous as collectors of pockets of explosive gases.

recovery. Also eliminated is the waste-heat boiler usually installed between regenerator and precipitator to lower the flue-gas temperature to a level suitable for operation of the precipitator. Without a precipitator in the unit, the use of this boiler is a matter of economics. The company's experience indicates that maintenance and operating difficulties far outweigh the value of the heat recovered, and that elimination of this boiler and the precipitator will end the major maintenance problems to be anticipated with fluid-catalyst cracking units.

Two-stage cyclone separators remove catalyst dust from hydrocarbon vapors leaving the reactor, rather than single-stage separators as used on earlier units. More complete removal of catalyst from these vapors results in a slurry stream from the main fractionator bottom with a much lower catalyst concentration, so that several troublesome problems related to slurry pumping and use as a heat medium have been avoided. Normal operation does not include the use of a slurry thickener, but a settling tank has been installed into which any excess production of slurry can be run to provide level control for the fractionator, the settled slurry being returned to the cracking system. Hot slurry is used as heat medium for the light-hydrocarbon fractionating tower reboilers. These reboilers are of standard horizontal design and to date have operated satisfactorily with no serious accumulations of catalyst muds on the slurry sides. Slurry also is used as main fractionator desuperheater section reflux, with a steam generator serving to recover a substantial portion of this process heat. More steam is generated by two recycle

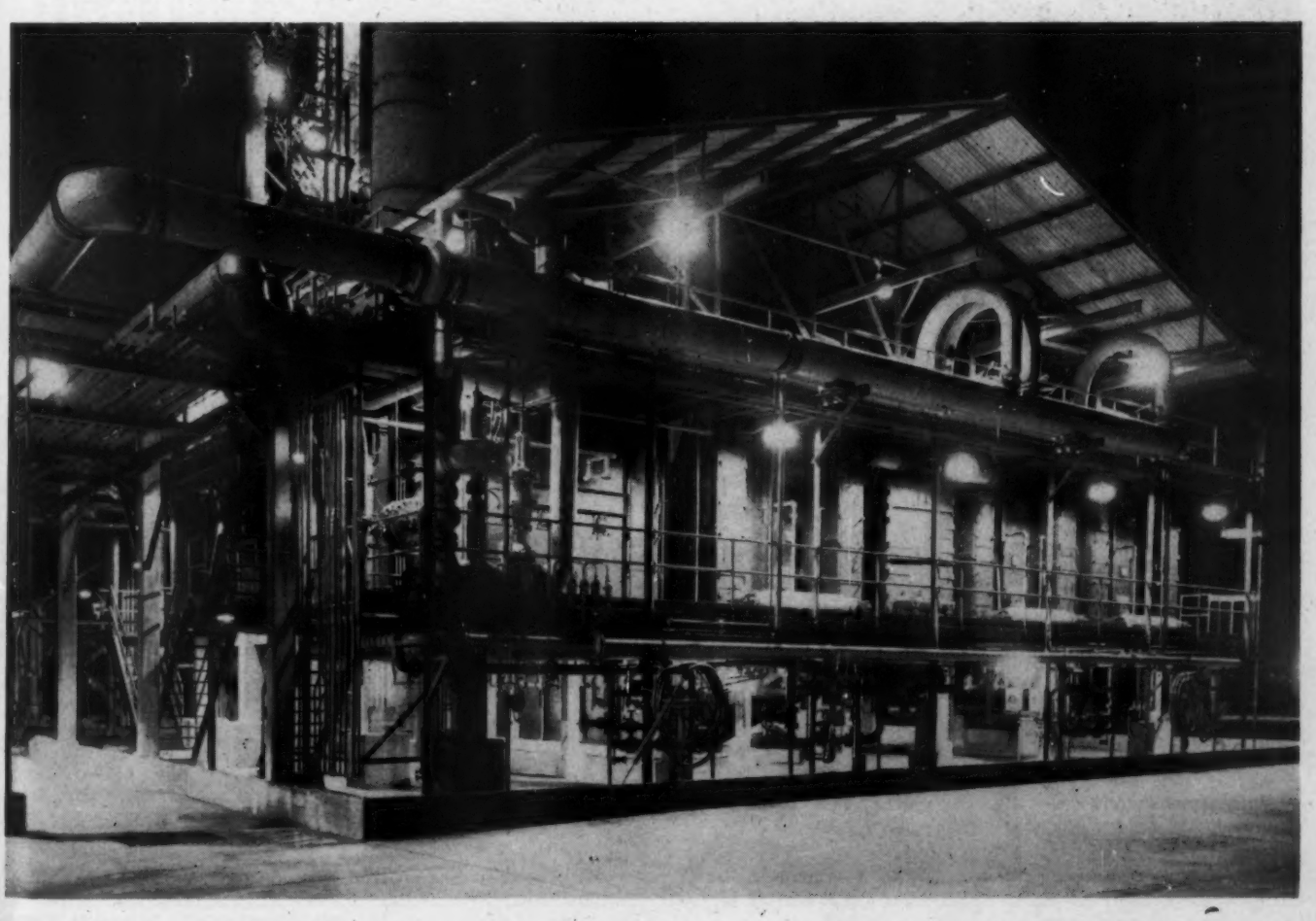


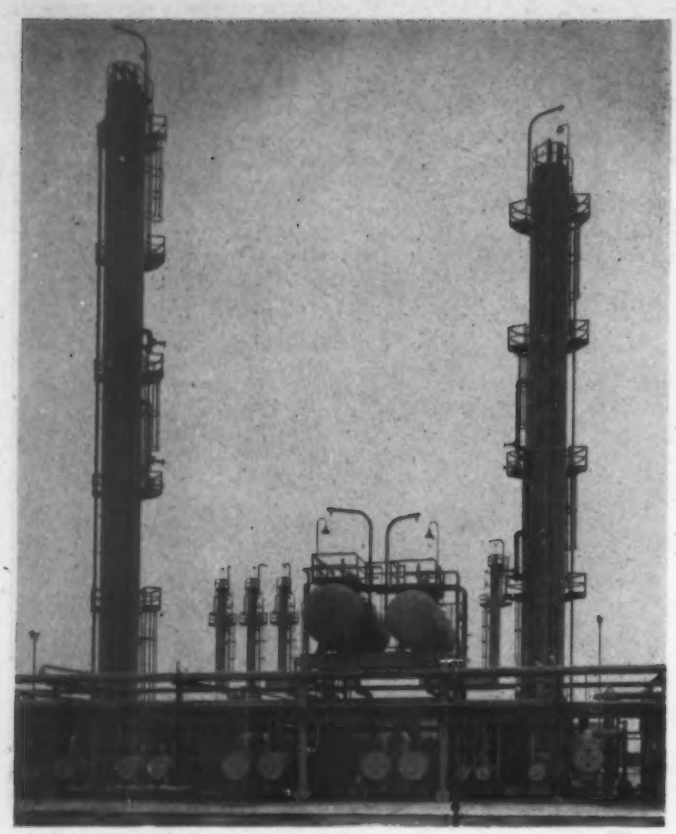
Exchanger Level

In the process equipment structure of the cracking unit. Ease of access to these exchangers. A traveling crane is provided for heat exchanger bundle removal.

Feed-Preheating Furnace

Firing is through the floor into four radiant heating sections. One section is devoted to steam-superheating service, and a common convection section preheats oil flowing to the radiant sections.





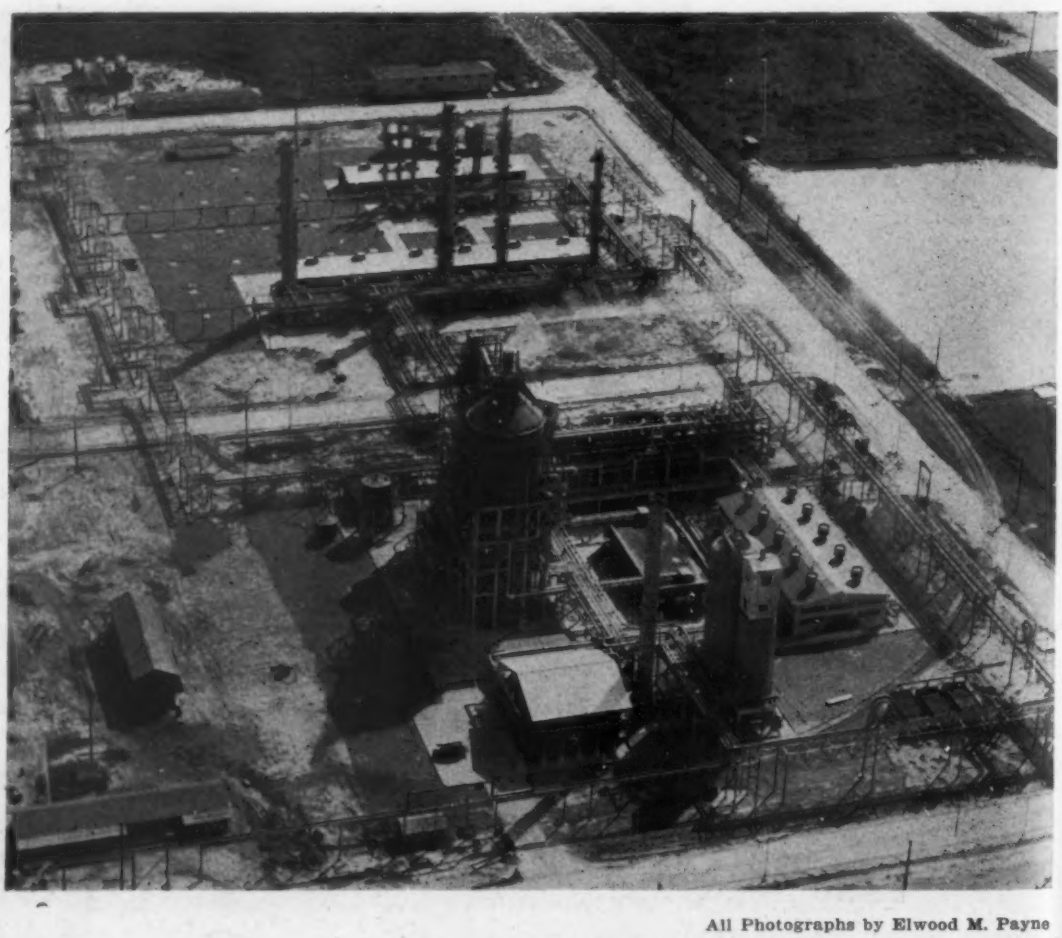
Light-Hydrocarbon Recovery

Small section of the light-hydrocarbon-recovery unit. All exchangers, including overhead condensers, are at grade level, providing maximum accessibility. Reflux drums are at sufficient elevation to provide satisfactory suction head for pumps.

catalyst coolers which remove excess heat from the regenerator catalyst bed, the total generation within the unit being such that it is independent of outside sources of steam except during start-up or emergency periods, and normally has an excess which is vented to the refinery steam system. A stripper has been designed to accomplish as thoroughly as possible the important function of stripping the spent catalyst leaving the reactor bottom. An "egg-crate" section is utilized, with catalyst flowing down between parallel plates which form cells that have individual stripping-steam connections. Both reactor and regenerator have been provided with grids to distribute the flow of vapors through the catalyst beds and to serve as partitions between "dilute-phase flow" regions of the reactor feed line and spent-catalyst carrier line and the "dense-phase beds" of the reactor and regenerator. The grids are of new design, being composed of hollow parallel beams which are spaced at intervals to form a series of parallel restriction orifices. The faces of these beams are fitted with wear plates which can be renewed when necessary, and the beams have been shaped to promote smooth flow through the restricted areas, so that erosion troubles are expected to be minor.

The unit is provided with a feed-preheat furnace which gives wide operating flexibility and allows the catalyst-to-oil ratio to be lowered to about seven, corresponding to a greatly reduced catalyst circulation rate and smaller catalyst system pipe sizes, so that piping layout is much simplified and erosion problems are lessened.

In addition to the catalytic cracking unit proper, there is also a new gas-recovery light-hydrocarbon fractionation unit, and a chemical treating unit to process products from the cracking plant.



Aerial View

Shows fluid-catalyst cracking unit in foreground, with light-hydrocarbon - recovery unit in rear. Two vessels in the foreground are used as fresh catalyst storage hoppers. Large building in right foreground is compressor house, and three-deck process equipment support structure is at center immediately behind main regenerator and reactor support structure.

All Photographs by Elwood M. Payne

W. E. BARR
Superintendent, Glass Shop, Gulf Research & Development Company

The Glass-Blowing Art In Petroleum Research

Photograph shows the author using a glass-tipped blowing tube and a carbon hand tool in moulding an apparatus mounted in lathe.

MODERN glass blowing, a development in which engineering and science are wedded to the best of the old free-hand glassblower's art, is playing a fundamental although little publicized role in making possible the research achievement of petroleum laboratories.

The contributions of glass to research, varying from hundreds of comparatively simple items to apparatus of surprising complexity, many of them incapable of duplication in any other medium, are so familiar they often go unrealized. To cite just a few properties of this amazingly versatile material which make it so useful in research:

It is chemically resistant and non-corrosive.

It is transparent, yet it can be silvered where opacity is desired.

Through modern technology, glass formulas are available which successfully resist reasonable extremes of temperature encountered in laboratory experimentation.

Designs requiring one tube within another formed into curves or bends yet allowing air space within the walls can be formed only of glass. The problems of bending metal tubing into such shapes are too difficult for practical use.

Double-walled tubes from which the air is expelled to create vacuum jackets, much used in petroleum research, can be fabricated only of glass; the occlusion of gas practically precludes the use of metals for such applications.

The purpose of the glass-blowing shop in the petroleum laboratory is to enable the research worker to use this unique material to the fullest advantage. The present discussion has been undertaken with the view of clarifying in general terms the operation of such a shop and its relation to petroleum research.

Like other research organizations, early petroleum laboratories were confined to the use of standardized products of commercial glass manufacturers, supplemented by the amateur glass blowing of the scientists themselves when individualized equipment was needed. As the scope of petroleum technology expanded, more and more specialized research apparatus was required.

Gulf Research and Development Company pioneered in the establishment of one of the first petro-

leum laboratory-glass-blowing shops. The innovation was undertaken to relieve research technicians of what had become an increasingly time-consuming sideline. An equally important consideration lay in the evolution of glass apparatus of such complexity that its production tested the most skilled profes-

sional glass blower, and far exceeded the abilities of most scientist-amateur glass blowers. In our own glass shop many weeks have been spent perfecting and modernizing instruments which incorporate old principles. An example is the improvement of the molecular-weight apparatus in which fragile inner parts are mounted rigidly in an evacuated vessel. Tedious manipulation is eliminated by supplanting wire connections with pronged radio tube-type bases. Some of the gauges, now standard in petroleum-research laboratories, represent striking examples of glass-blowing skill. One of these, The Bourdon gauge, constructed entirely of glass, is designed with such extreme delicacy that it measures pressures on a glass diaphragm by exaggerating the effects through a series of finely-drawn glass levers.

Specialized Uses

The laboratory-glass shop is intended to supply research needs in equipment not available from commercial manufacturers, either because it has not yet been designed or generally adopted, or because it is needed for such a specialized use that its quantity production would not be warranted. The laboratory shop supplements, but in no sense competes with the commercial apparatus companies. Indeed the fullest use is made of the products such firms supply.

A large stock of standard glass equipment represents one of the first requisites of the laboratory shop. This stock includes standard round and cylindrical glass bulbs, and both thick- and thin-walled tubing in many sizes, as well as large and small capillary tubes. Tapered and spherical ground joints and stop cocks in a wide range of sizes are included. These standard parts are available in both soft glass and various compositions of Pyrex. Also available, although outside the range of glass, is quartz, known professionally as vitreous silica. Vitreous silica has all of the desirable properties of glass and in addition will transmit ultra-violet rays.

The equipment of a modern laboratory shop includes glassblowing machines for the most part designed especially for laboratory work. One of the most important of these machines, indispensable for handling large glass apparatus, is the glassblower's lathe, quite similar in size and design to the machinist's lathe, although geared to turn more slowly. Since the glass is soft when worked, both heads of the lathe must be driven in synchronization to avoid twisting the apparatus at the critical sealing point.

The men in the two pictures, which show two stages of one fabrication, are W. E. Barr and Carl Hepler. At left they are completing a ring seal between a six-inch cylindrical blank and a 20-liter flask. Barr, at left, is tooling the seal with a flat carbon against the heated glass. Hepler is preheating an arm preparatory to making a side-entry tube on the flask. Both men are wearing neophan goggles, which eliminate sodium glare and give the technicians a better perspective of the progress in sealing.

The principal tools of the glass blowers are, of course, the burners and torches used in heating the glass. Expert glass blowers are proficient in choosing the proper fuel and adjusting the flame for most efficient heating. The type of glass to be worked determines the choice of gas to be used as fuel. Natural gas mixed with air produces a flame sufficiently hot to fuse soft glass. However, to work successfully with Pyrex the necessarily higher temperatures are obtained by substituting oxygen for air. Vitreous silica and high-silicon glasses require even

hotter flames, such as those produced by mixtures of oxygen and acetylene or oxygen and hydrogen. Cross fires are used for bringing the glass to uniform working consistency; hand torches, for assembling glass systems; and large single-bench burners for annealing. Torches and burners are supplied commercially but, for special work, may be designed in the shop.

The small hand tools used in glass working include forceps and shaping and flaring tools, made of graphite or brass with Transite handles. Blowing tubes are rubber, fitted with glass mouth-pieces; and aluminum swivels, which are necessary to permit rotating the glass without entangling the blowing tube, are inserted at a convenient point in the blowing tube. To hold the work, well-designed racks with firm clamps add to the ease of assembly and the durability of complicated apparatus.

High-Vacuum System

Because much of the work of the scientist in the laboratory is done under high-vacuum conditions, an efficient high-vacuum system should be an integral part of the glass-blowing shop for complete processing of evacuated apparatus. The development of glass-laboratory exhaust pumps has paralleled the development of the larger commercial metal pumps, since it is more economical to build the smaller condensation pumps of glass.

For ordinary work, a partial vacuum is created by the use of rotary-vane mechanical vacuum pumps. These pumps, which are obtainable commercially, are capable of producing pressure in the order of 1.0 to 0.01 mm, of mercury in a closed system. If a high vacuum is required, a condensation pump must be used in series with the rotary pump. Condensation pumps are of two classes; one with mercury as a diffusion medium and the other using high-boiling organic liquids. By using a cold trap on a mercury pump system, vacua of 10^{-6} mm. of mercury can be obtained. A well designed pump of the oil type can produce vacua of 10^{-9} mm. of mercury in conjunction with a cold trap.

Learned by Experience

Finally, and most important to the shop, is a staff of experienced glass blowers. The art is one that can be learned only through years of experience, ten years generally being considered the period of apprenticeship. Personnel selected to learn the trade must have nearly inexhaustible patience and an aptitude for work with precision tolerances. Women, who entered the shops to replace men during the war, have been found well suited to the more delicate work.

Frequently designs for glass apparatus submitted to the laboratory-glass shop are either not within the possibilities of glass blowing or will prove impractical in use. An experienced glass blower discovers these difficulties at once, and will try to suggest changes or modifications which will give an apparatus which can be built properly and still accomplish its research purpose.

First of all, it is the responsibility of the glass blower to point out to laboratory workers the limitations of glass. Laboratory glasses have been developed to withstand the extremes of high and low temperatures encountered in research use. However, even Pyrex Vycor, an extremely hard, thermal-resis-

Below, Gerald Gerhart is adding a side arm to a Fischer-Tropsch apparatus, holding it over a single-blast oxygen gas burner. At right, William Kravenko uses a cross fire to make a bend in a tube joined to a Fischer-Tropsch apparatus. Standard items, such as these graduated glass tubes, are used in the fabrication of special laboratory equipment in the Gulf Research & Development Company's glass shop.

tant product, is not designed to withstand too sudden temperature changes. Other varieties of Pyrex must be used within the temperatures for which they are designed, and not subjected to temperatures beyond the softening point. Moreover, in designing glass apparatus an understanding of the fundamental seals used in glass blowing is most helpful to the scientist. Fundamental types which should be familiar to all who undertake designs are the "butt seal," used for joining the ends of sections of tubing; the "side seal," used for attaching tubes entering the side of a bulb or another tube; and the "ring" or "triple seal," used when one tube passes through the end or side-wall of another.

It must be remembered that torch seals in a fixed glass system are more easily made when the glass tubes are in a vertical rather than a horizontal position. The gravity flow of fused glass makes horizontal seals more difficult and less satisfactory than vertical seals. Horizontal torch seals must be made by fusing a short section of the circumference of the tubes, a slower and less certain method, than the sealing together of vertical tubes. Other considerations in the assembly of apparatus is to have smooth bends and the parts placed where a torch can conveniently be used for repair and maintenance. An adequate number of sturdy clamps is essential for a neatly arranged glass laboratory system.

No Routine Job

Considerable planning by the glass blower and research engineer is necessary to properly mount an intricate apparatus on a rack for laboratory use. However, such work is no mere routine job. An experienced glass blower may spend several weeks fabricating the design for a complicated still or vacuum system.

The possibilities and limitations of glass-to-metal seals also should be understood generally. The actual fabrication of such seals calls for all of the experience and skill of the professional glass blower, since only those thoroughly versed in the technique can make vacuum-tight junctions. This accomplishment, requires, first of all, the selection of the correct glass to join with the prescribed metal. The behavior of heated glass is peculiar. It expands at a uniform rate to near its melting point and then rapidly increases its expansion.

Therefore, not only is it necessary to select a glass with a coefficient of expansion similar to that of the metal to which it is to be sealed, but careful consideration must be given to the transition curves of the two materials. Combinations of metal-to-glass seals are encountered in sealing metal conductors into glass apparatus.

Metal and Glass

The use in the same apparatus of metal and glass of unlike expansion characteristics can be accomplished by means of what is known as a "graded seal." First a ring of the proper type glass is sealed to the metal. Another ring, of a different type glass, but within tolerance limits, then is joined to the first seal. By repeating the process with glass rings of slightly different characteristics, a metal and a glass of differing expansion curves finally can be sealed together in the same apparatus. A similar problem is presented when vitreous silica, harder than glass, is needed in a laboratory apparatus joined to glass. Here it is necessary to use a series of seals graded from the softer glass to the very hard vitreous silica. Sometimes the problem is solved by tapering copper tubing to a feather edge at both ends and sealing each end to glass types which differ greatly in their expansion coefficients.

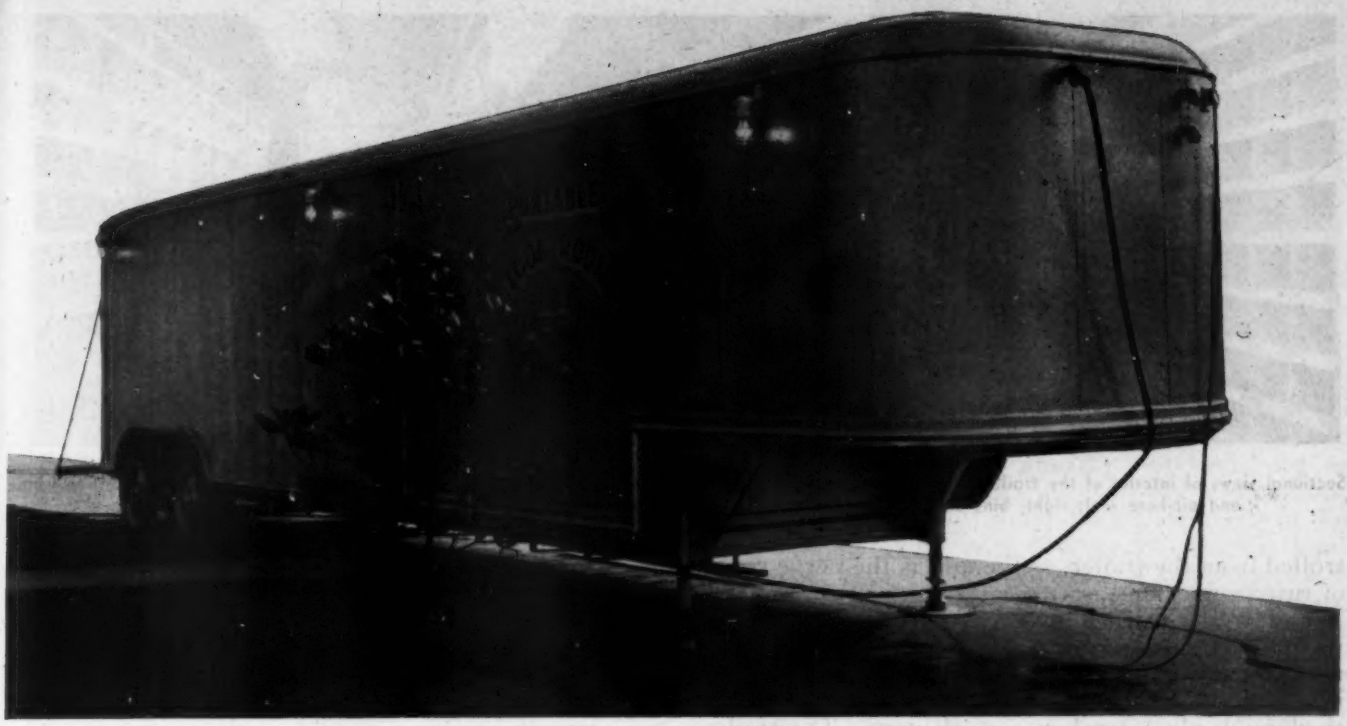
There are still other ways to surmount difficulties imposed by the expansion limitations of glass. For example, it is frequently necessary to furnish distillation equipment with columns equipped with vacuum jackets. In these columns the inner tube is subjected to much higher temperatures than the outer wall. To compensate for differences in length due to expansion, a bellows is formed on the outer tube prior to assembly and evacuation. This bellows allows enough flexibility to prevent breakage when the inner and outer tubes are subjected to opposite extremes of temperature.

The laboratory-glass blowers' work never becomes repetitious. Glass shops may duplicate special apparatus previously made, or alter old equipment to suit new applications. Gradually a new design may become standard with the laboratory. As a result of the exchange of ideas between laboratories, it may be adopted eventually by the industry. In such cases the apparatus is likely to be accepted for routine manufacture by a glass-apparatus company. In this way the laboratory-glass shop is continually providing contributions to the industry as a whole but, in itself, never becomes static. As a design is made standard, the glass shop's resources are devoted to new problems encountered in pushing back the frontiers of petroleum research.

Maintenance and Repair

Besides constructing new apparatus, the glass shop provides a valuable service to a laboratory in the maintenance and repair of glass apparatus. Even the best equipment, both standard and specially fabricated, needs repairs after use in rigorous tests. Such repairs are economical and, in addition, save the time required to secure new equipment. Frequently it is possible to modify standard commercial equipment in such a way as to make unnecessary the construction of a complete new assembly.

The glass shop's role in research may seem to be a humble one, yet within its scope it is highly creative. Certainly scientific research would have been forced to seek very different approaches to the solution of its problems if it were not for development of present glass-fabrication techniques.



Trailers Increase Maintenance Efficiency

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Magnolia Petroleum Company, Beaumont, Texas

TWO mechanical-maintenance trailers which serve as portable tool rooms and storehouses have been placed in operation at Magnolia Petroleum Company's Beaumont, Texas, refinery. These units were conceived, designed and equipped by the refinery personnel and are increasing the efficiency of mechanical-maintenance work by minimizing time required to obtain tools and materials, permitting maximum use of tools, and increasing the useful man hours of personnel on jobs served by the units.

General Description

The van-type trailers are low-slung semi-trailers of 35-foot length with the floor 2 feet above ground level. Tandem rear wheels eliminate the usual wheel housings which prohibit a full-width floor. Screw-type landing gear with 6-foot-wide footings support the front end while the trailer is parked without the truck-tractor.

Standard metal bins are used to store tools and stock. A panel wall is provided to hang gaskets and similar items. Racks are provided for air hose, electric cords, long rods and bulky tools. Fluorescent lighting, electric air heater and electric blowers contribute to the efficiency and welfare of the attendant.

A telephone connection to the plant system keeps each trailer unit in contact with the storehouses and mechanical shops. The annunciator system is con-

Interior of trailer viewed from tailgate

Sectional views of interior of the trailer. At left, bins, buffer-emery wheels and section of gasket rack; center, telephone, annunciator set, tool bins and air-hose reel; right, bins on opposite side from center picture, showing hose reel and chain blocks stored at the back.

trolled from the trailer, as the unit is the nerve center of turnaround jobs.

The trailers serve process unit turnaround and repair jobs, but are not used on extended jobs or on major construction projects. Their principal function is to supply all tools normally required on the particular job plus storehouse stock items. The trailers always have a complement of general tools and stock; but prior to moving to a particular process unit, all special tools, gaskets and stock items peculiar to that unit are loaded. In addition to the material in the trailer, other items and extra stock are delivered to the trailer and dispensed by the attendant. All tools are controlled by tool checks and are returned after a shift or checks exchanged with relieving personnel.

Advantages

The most obvious advantages of the mechanical maintenance trailers are:

1. Time saved in locating tools and materials.
2. Reduced time lost in waiting for deliveries.
3. Reduced quantity of lost and misplaced tools.
4. Reduced quantity of storehouse stock left after job completed and usually damaged by weather and mishandling.
5. Maximum use of tools.

Special Features

The magnitude of the major functions one of these trailers perform on turnaround jobs may be visualized through the following résumé of tools and equipment.

1. Adequate supply of commonly-used tools — drive and end wrenches, impact wrenches, sledges, blinds, gaskets, air hose, electric extension cords, etc.
2. Gaskets peculiar to unit being worked — metallic, ring, exchanger, pumps, etc.
3. All furnace-cleaning and tube-rolling equipment.
4. Exchanger-cleaning and repair equipment.
5. Pump packing, tools and repair equipment.
6. All gages, calipers and special tools used in corrosion inspection.
7. Spare parts and electrodes for welders.
8. Stud and machine bolts, pipe nipples, fittings and valves.
9. Test rack for BRD electric cords.
10. Small parts—screws, bolts, nails, fastenings and other parts used by electricians, instrument men, machinists and other crafts.
11. Waste rags, white lead, cements, etc.
12. Two locked drawers for overnight storage of valuable precision tools.
13. Small grinder and vise on work bench.
14. Pipe taps and dies, and other machine tools.
15. Desk for attendant to maintain records, file orders and other paper work.
16. Telephone and annunciator systems.

Dispenser-counter of trailer

Storage Space

To effectively utilize the 260 square feet of trailer floor space, standard steel bins and a panel wall are used. These bin units are very versatile in that spacing between shelves and also between bins may be quickly and easily altered to meet changing conditions. Each unit contains 535 bins, varying in size from 6 x 6 x 12 inches to 36 x 18 x 18 inches, and 73 drawers, varying in size from 5½ x 1-15/16 x 16-11/16 to 20 x 6 x 19¾ inches.

A usable 185 square feet of center panel wall is equipped with hooks for gaskets and tool checks.

All material is stored in bins or on the panel wall except air hose, chain blocks, electric cords and heavy tools. These latter items are stored on special racks at the end of trailers.

All bins are labeled and tool-check hooks are provided on tool bins.

To combat atmospheric corrosion, all surfaces of the all-steel trailers were thoroughly painted.

The successful operation of the trailers depends a great deal on the capabilities of the attendants. Experience on all unit turnarounds, knowledge of tool and storehouse stocks, initiative and aggressiveness are some of the major qualifications.

Warren Gasoline Plant Designed For Operation Without Steam

C. C. PRYOR, Associate Editor

LACK of an adequate water supply for operation of a gasoline and repressuring plant in Archer County near Holliday, Texas, resulted in the design and construction of a plant by Warren Petroleum Corporation in which steam generating equipment was eliminated and water requirements reduced to a minimum. In the opinion of the corporation's engineers, operating costs for a conventional type plant requiring steam and water would have been excessive and profitable operation with the desired capacity at the location impossible. Initial operation of the plant indicates that future operation will be simpler and maintenance requirements fewer than in the conventional plant.

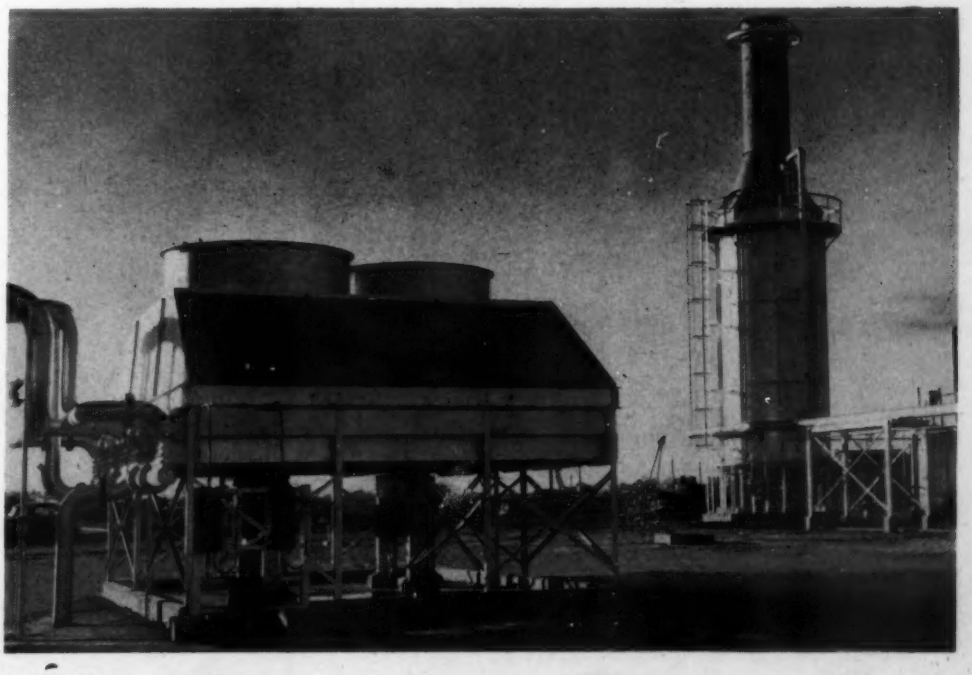
If the conventional steam system had been employed, expensive treating of boiler-feed water would have been necessary and steam condensation equipment installed to reduce the volume of treated feed water. Despite these precautions, it was believed that scaling and clogging of boiler tubes would require frequent cleaning. Large volumes of cooling water would have required treating, but the possibility of scale formation on the cooling coils and tubes would seriously reduce plant efficiency. Finally, the procurance of an adequate water supply for steam and cooling purposes was doubtful without an excessive investment in pipe lines and pumps.

All heat requirements of the plant are supplied by a direct-fired heater, which heats the rich absorption oil charged to the still. The rich-oil heater is a furnace with 20,000,000 Btu capacity, having 50 4½-inch outside diameter tubes. The hot lean oil from the still is used to heat the reboilers for the depropanizer and debutanizer, preheat feed to the rich-oil heater from the absorber, preheat feed to deethanizer, preheat stripping and agitation gases, and to heat the control room. Steam stripping in the still is eliminated by using the vapors from a rich-oil flash taken between the rich-oil heat exchangers and the direct-fired rich-oil heater. These vapors then are heated by oil introduced into the still as agitation gas.

Approximately 80 percent of the cooling in the plant is accomplished with air coolers. The system requires 20 gallons per minute of make-up water, which is supplied from a small well and treated in a continuous unit with soda ash, lime, and alum. This water is used in the small two-cell, induced-draft cooling tower used for final cooling. The water is circulated over the tower by vertical pumps electrically driven. Engine-jacket-water make-up is supplied from the second-stage condensate, and compressor-jacket-water pumps belt-driven from the compressor engines circulate the water through the air coolers. Final cooling in the cooling tower is used for second-stage gas during the summer months, absorber intercooling, lean-oil cooling, gasoline condensing, depropanizer overhead, debutanizer bottoms, and debutanizer overhead.

Electrical power is supplied by three 270-horsepower, 250 KW generators. Electricity is used for plant and camp lighting and driving all plant pumps except the fire pump which is driven by an internal-combustion power unit.

The plant was designed to process 15,000,000 cubic



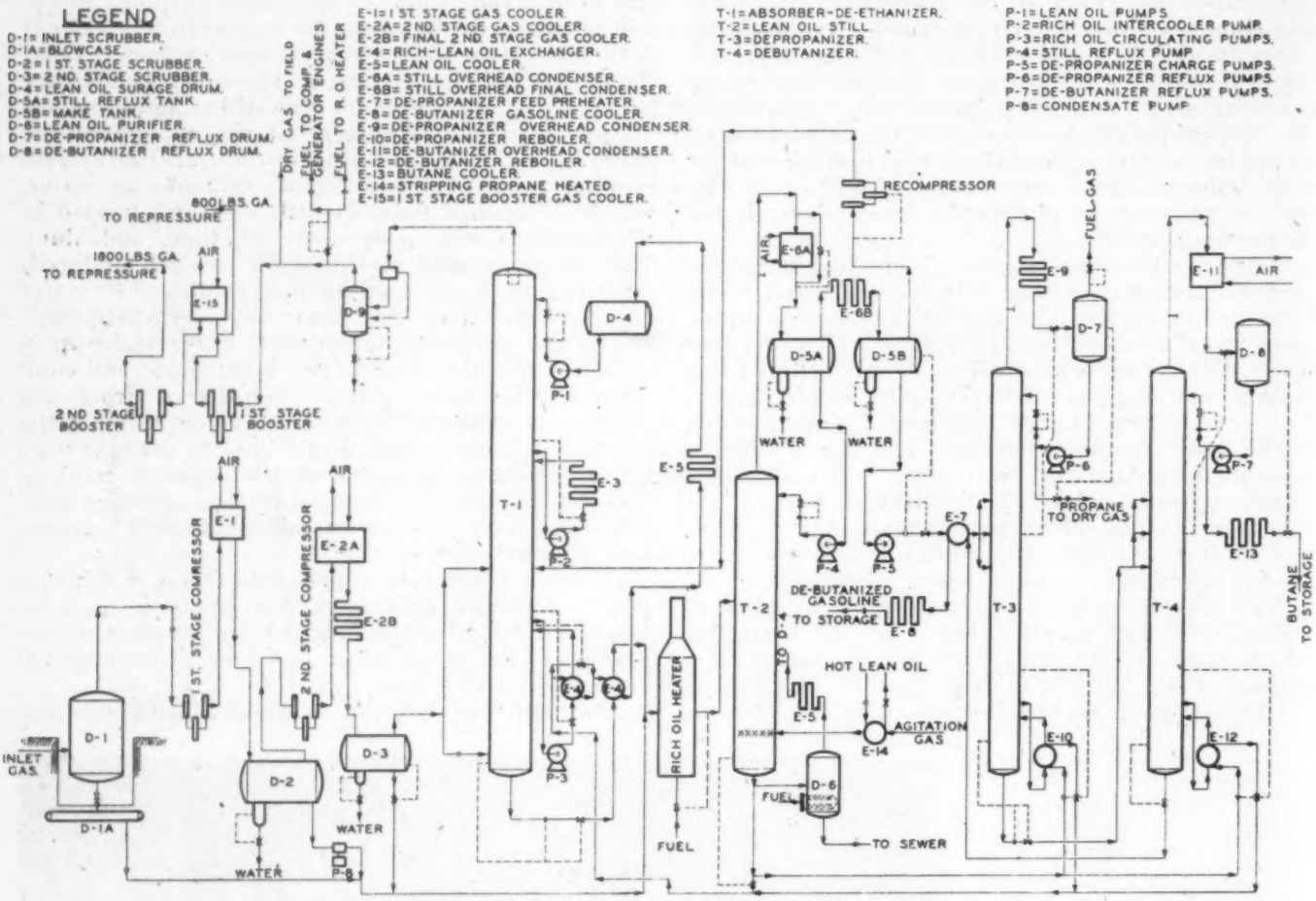
Induced-draft air coolers cool engine-jacket water, gas from the first stage of compression, primary cooling on the second stage of compression, primary still overhead product, and debutanizer overhead product. Heat supply for the plant is obtained from the vertical furnace in the right background. The small direct-fired heater (at extreme right) vaporizes a side-stream from the larger furnace, which is condensed and returned to lean-oil surge tank, continuously conditioning absorption oil.

feet daily and is recovering approximately 5 gallons per 1000 feet. Gas is brought to the plant at 5 inches Hg vacuum from field separators on which atmospheric pressure is maintained by regulators in the meter runs. An average analysis of the field gas is as follows:

Hydrocarbon	Mol percent
C_1	65.64
C_2	9.99
C_3	11.90
i-C_4	1.35
n-C_4	5.37
i-C_5	1.89
n-C_5	2.26
C_6	1.60
	100.00

The tower is 86 feet in height. A water-cooled intercooler is used between the 13th and 14th trays from the top of the absorber. Butane recovery in the absorber is substantially 100 percent and propane about 60 percent. Increased propane recovery can be effected by increasing the oil rate. Approximately 332 gallons per minute of absorption oil at 90° F. is pumped over the absorber by the electrically-driven centrifugal pump.

Methane and ethane in the rich oil from the absorber are essentially all removed by pumping the oil through heat exchangers and heating it with the lean oil from the still, then returning it to the deethanizing section of the tower. The oil passes through three heat exchangers, entering at 120° F. and leaving at 280° F. The methane and ethane are flashed from the oil as it flows down the trays. Gas



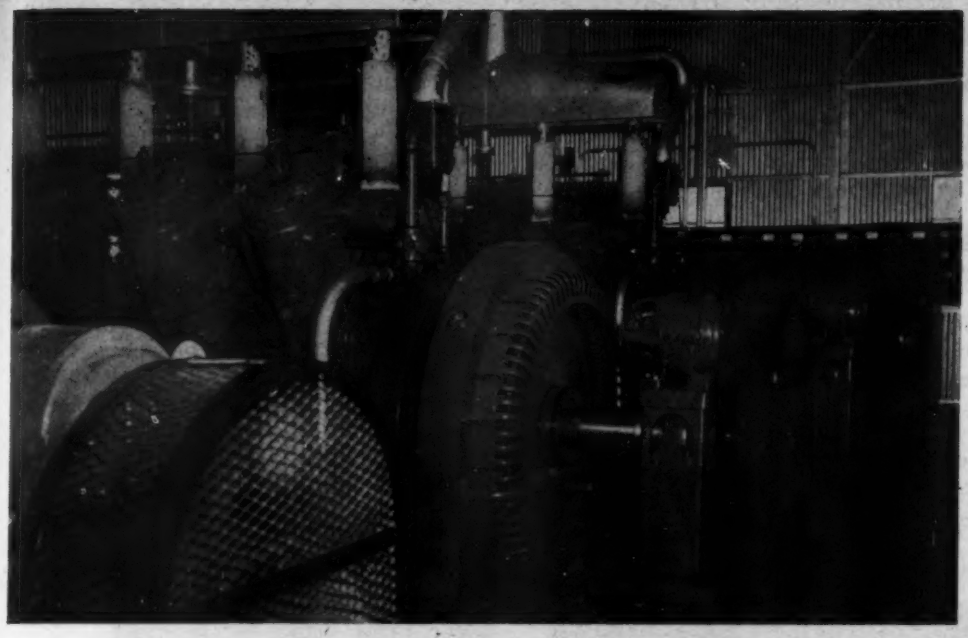
Flow diagram, Warren Petroleum Corporation's Plant No. 27, Holliday, Texas.

Five 625-horsepower compressors increase the gas pressure to 200 psig through two stages of compression. The first stage discharges at 45 psig to the air coolers and delivers the gas through the scrubber to the second stage of compression at 40 psig. Gas discharged at 200 psig from the second stage flows to the air coolers for primary cooling and then to the cooling tower for final cooling.

Absorber-Deethanizer Combined

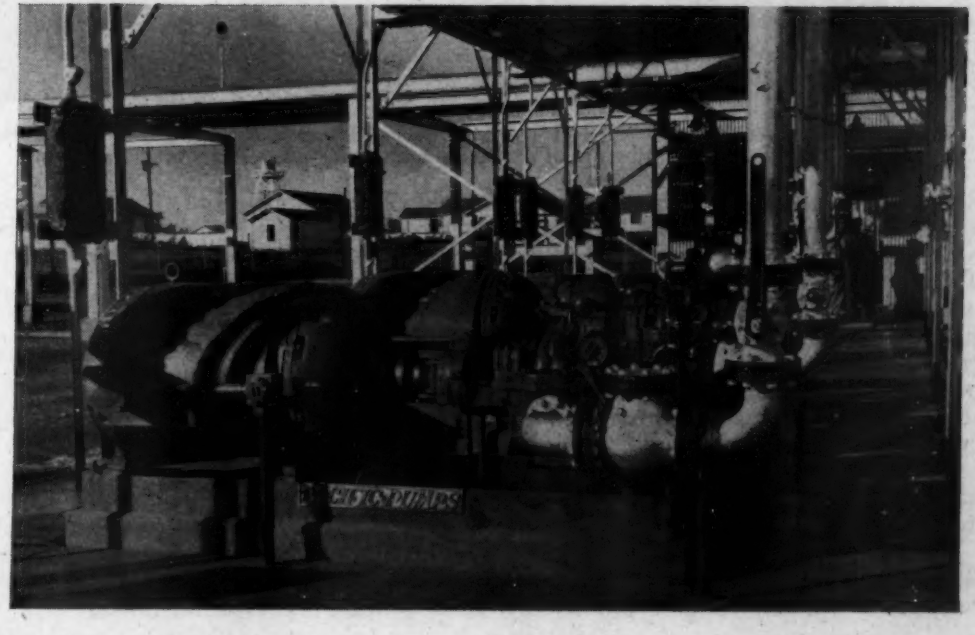
From the cooling tower, the gas enters the combination absorber-deethanizer tower. The top section of this tower is the absorber which has 20 trays, and the bottom section is the deethanizer with 8 trays. for agitation is injected into the base of the deethanizer section above the liquid and below the first tray, and flows up through the deethanizer to enter the bottom of the absorber. A small recycle of butane and propane results, but the rich oil is stripped of practically all methane and ethane when it reaches equilibrium.

The lean oil from the still at 420° F., after being used for the heating purposes previously described, is given a final cooling in the cooling tower and returned to the lean-oil surge tank. The absorption oil is continuously reconditioned. A small direct-fired heater vaporizes a side-stream from the system, which is condensed and flows to the surge tank. The



Process and utility pumps in the plant are driven by electric power supplied by three 370-horsepower gas engines direct-connected to 440-volt, 3-phase 60-cycle generator units.

Processing area of the Holliday plant. Open-air shelter for pumps eliminates hydrocarbon vapor accumulation due to leaks. Combination absorber-de-ethanizer tower is shown at right, and still, depropanizer, and debutanizer at left.



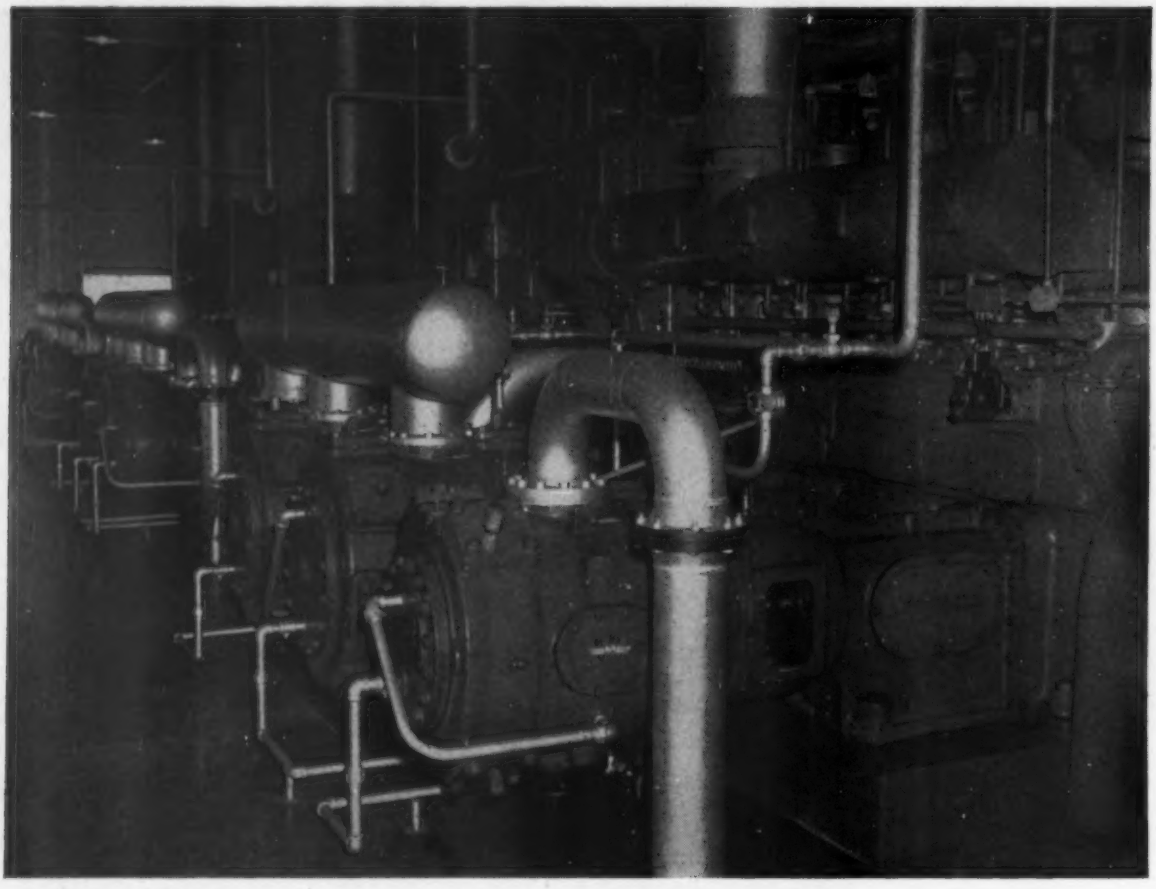
Electric-powered centrifugal pumps for lean oil and rich oil service in the open-air shelter south of control room.

plant is presently operating with a lean-oil saturation of 0.5 percent.

Residue gas from the absorber is used for plant and field operation and also for repressuring into the various zones near this plant. Two million cubic feet of residue gas is compressed to 1800 psig and is used for repressuring in the Daume and East Holliday zones. It is planned to compress an additional six million cubic feet of gas from 200 psig to 800 psig for repressuring in the Hull-Silk field. All of this repressure-gas will be cooled and dehydrated with a solid-desiccant type unit before entering repressure lines to the field.

Stripping

Rich absorption oil from the deethanizer is preheated in three heat exchangers by the hot lean oil from the still to about 280° F. and charged to the direct-fired heater. Leaving the heater at 525° F., the oil flows to the combination still and dephlegmator.



Five 625-horsepower angle-type compressors increase gas pressure from 5-inches-Hg vacuum to 200 pounds per square inch, gauge, in two stages before processing.

Stripping is accomplished by using a portion of the vapors that are flashed from the rich oil between the heat exchangers and the direct-fired rich oil heater. This is a departure from the conventional method of using steam for agitation in the still. Overhead gas from the still at 100 psig is cooled in fin-tube air coolers (primary coolers) to supply condensate to the primary accumulator for reflux to control the top temperature of the still. Vapors from the primary accumulator are given a final cooling in the cooling tower and flow to the raw-make tank. Uncondensed vapors are picked up by the recompressor at 95 psig and returned to the absorber feed line at 200 psig.

The plant was designed to produce natural gasoline and a butanes-propane mixture, which requires only two fractionating columns. Provisions were made during construction, however, to install additional fractionating equipment when other products are required.

Condensate from the raw make tank at 80° F. is pumped to the depropanizer through a heat exchanger with the bottoms from the debutanizer and enters the depropanizer on the 15th tray. The propane and ethane are rejected for the butanes-propane mixture desired. Overhead vapors from the depropanizer flow through the coolers to the accumulator tank for refluxing, and vapors from the reflux tank enter the residue system. Bottoms of the depropanizer flow under pressure to the debutanizer for separation into the desired butanes-propane mixture and natural gasoline having the desired vapor pressure.

Debutanizer overhead vapors flow through the primary fin-tube air cooler to the reflux accumulator. The butanes-propane mixture is final cooled in the cooling tower before going to storage. Natural gasoline from the debutanizer passes through a heat exchanger heating the raw condensate charge to the depropanizer and then flows to storage through a section in the cooling tower. An analysis of the natural gasoline produced in the plant is as follows:

Distilled at 100° F., percent	26
Distilled at 140° F., percent	67
I.B.P., °F.	78
Recovery, percent	98
Gravity, °A.P.I.	83.6
Corrected R.V.P., lb.	17.9
End Point, °F.	328

Production of natural gasoline is stored in three horizontal tanks, 12 feet by 59 feet, and the butanes-propane mixture is stored in three 9 feet by 60 feet horizontal tanks.

Fractionator Pressure Control

DAVID M. BOYD, JR.

MOST fractionation-control systems are predicated upon having a constant pressure within the column. This pressure might be atmospheric, vacuum or high pressure. Any variation from this pressure will upset the control system by changing the equilibrium conditions. The methods used to obtain this constant pressure are, the mechanical design of the equipment, and proper instrumentation. The choice of the latter is dependent upon the former.

Fractionation control problems usually can be separated into one of the following types:

Type 1. Atmospheric Distillation
Type 2. Vacuum Distillation
Type 3. Pressure Distillation
  Case A. Large Amounts of Inerts
  Case B. Small Amounts of Inerts (overhead product desired as liquid)
  Case C. Mixed Inerts and Vapor (overhead product desired as liquid)
  Case D. Mixed Inerts and Vapor (overhead product desired as a vapor).

It is the purpose of this paper to outline a control system for each type of fractionation control problem.

Type 1. Atmospheric Distillation

Naturally, the usual type of atmospheric distillation will not require any sort of control instruments. The only requirements are to locate a rather large vent on the receiver to equalize the pressure, and to size the vapor and condensate lines large enough to keep the column at substantially the same pressure as the receiver regardless of the load on the column.

However, on certain fractionation problems requiring very close control of the tower, it is often necessary to install an absolute pressure controller and handle the tower as in Type 3, Case B. The tower pressure is maintained just slightly higher than the highest atmospheric pressure expected in the area in order to permit the purging of inerts that might accumulate in the system.

If the absolute pressure controller is not used, it will be found that an overhead product will be off specification as the barometric pressure changes, even though the temperature remains constant.

Type 2. Vacuum Distillation

A vacuum distillation column is essentially a pressure-distillation unit with the pressure of the system controlled by the amount of inerts present. The system operates under total condensation and the condensation rate in the condenser is inversely proportional to the amount of inerts that are blanketing the condensing surface. The inerts are pulled off by a vacuum source at a rate controlled by the pressure controller.

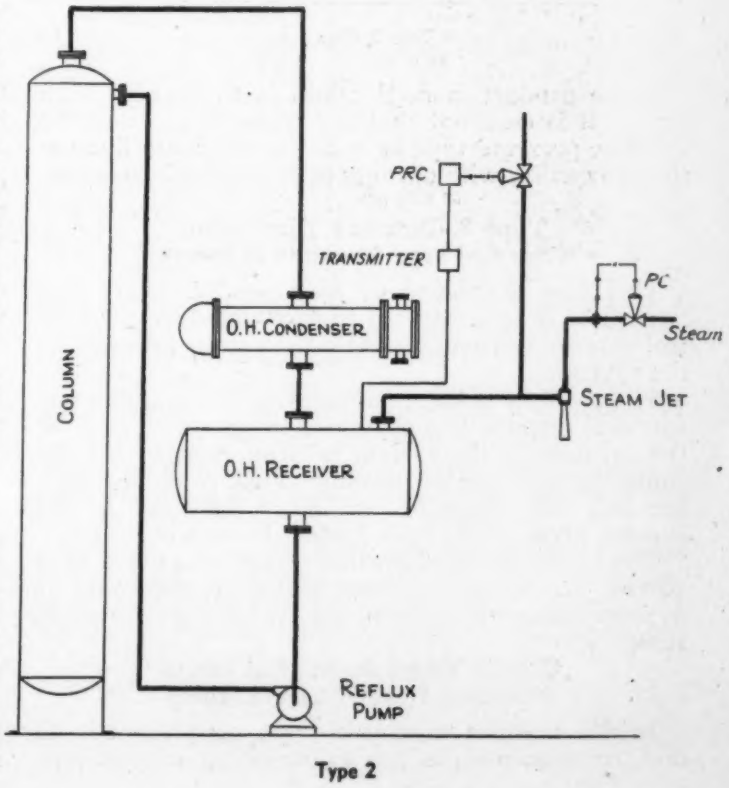
The most common vacuum source used on fractionation columns is the steam jet. It has no moving parts and requires very little maintenance. It is, however, sensitive to changes in steam pressure, and for this reason, it is advisable to install a pressure controller on the steam to keep it at the optimum steam pressure required by the jet.

It is not possible to control the system by controlling the steam to the jet, as the capacity curve of a given jet has a very abrupt break as the steam pressure goes below the critical value for the jet.

The recommended control system for this service uses a control valve to bleed air or gas into the line just ahead of the jet. This makes the maximum capacity of the jet available to handle any surges or upsets in the system. It is not recommended to place the control valve in the line leading to the jet as the additional pressure drop across the control valve would greatly reduce the capacity of a given jet.

It is recommended that the receiver pressure be the controlled unit in a vacuum-distillation system as this will involve the least time lag and, consequently, a very narrow throttling range can be used.

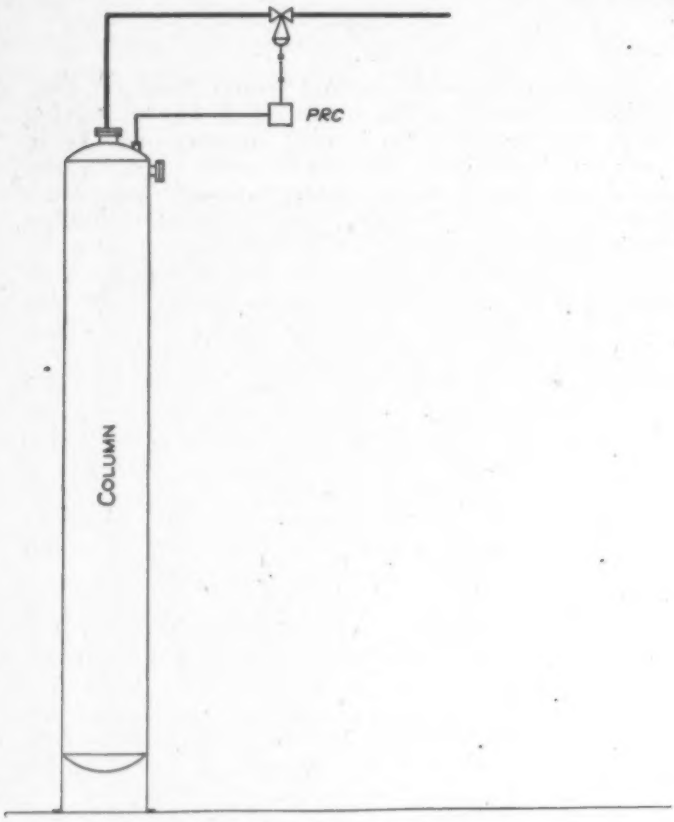
The pressure of the rest of the system will be proportional to the receiver pressure and will differ only by the vapor losses in the vapor lines, risers, bubble



Type 2

caps, condenser, etc. It is necessary for good control (and operation) to reduce these vapor losses to an absolute minimum in order to prevent pressure changes in the column with any changes in the vapor-flow rates.

The pressure controller, used on a vacuum control system, should be provided with a pressure transmitter. This transmitter should be located above its pressure top and have a slight bleed of air or gas into the line in order to keep it free of any condensate that might otherwise collect in this line and give a false reading.



Type 3, Case A

If the product from this still is to be of a high purity, it is essential that the transmitter be of the absolute-pressure type in order to eliminate fluctuations in quality with changes in atmospheric pressure.

Type 3. Pressure Distillation
Case A. Large Amounts of Inerts

This case is typified by an absorber. There is a large flow of gas that can be modulated by the control valve in order to maintain the proper pressure on the system.

The gas flow is large enough that the system pressure will respond to a change in the gas flow, and yet the capacity of the system is large enough that the controller will not be unstable. This, combined with the fact that there is very little time lag in the system, gives a very easy system to control.

The controller used on this service can use a very narrow throttling range and, therefore, need only be a proportional controller, not requiring automatic reset.

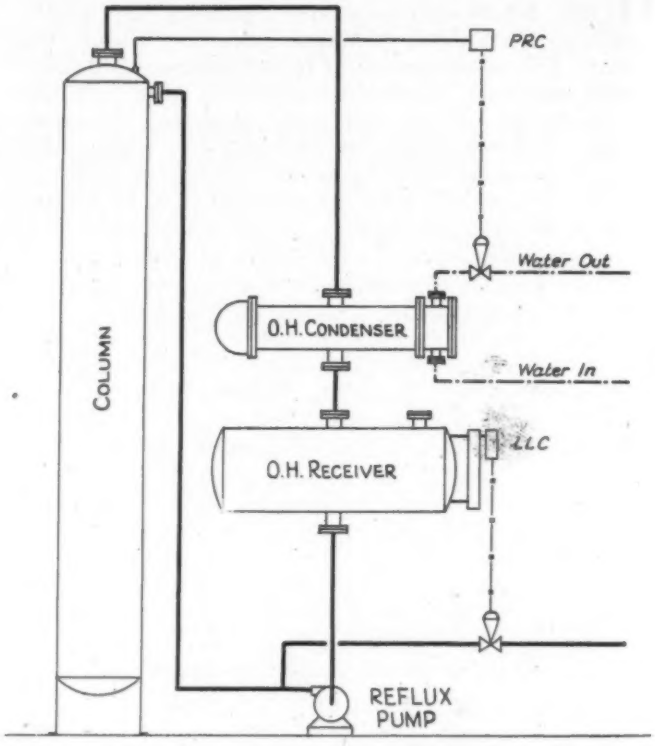
Case B. Small Amount of Inerts (Product Desired as a Liquid)

In this case the amount of inert gas present is nil and, consequently, is not available for control purposes. This system is, therefore, controlled by the rate of condensation in the condenser.

The method of controlling the rate of condensation will depend upon the mechanical construction of the condensing equipment.

The recommended method of control is to place the control valve on the cooling water flow from the condenser. This system requires the least maintenance and will give very satisfactory service, provided the condenser is designed properly.

The best condenser for this service is a bundle type with the cooling water flowing through the tubes. This water should be flowing at a rate of 4½ feet per second, and the water should have a sojourn time of



Type 3, Case B

less than 45 seconds. The shorter the sojourn time for the water, the better will be the control obtained.

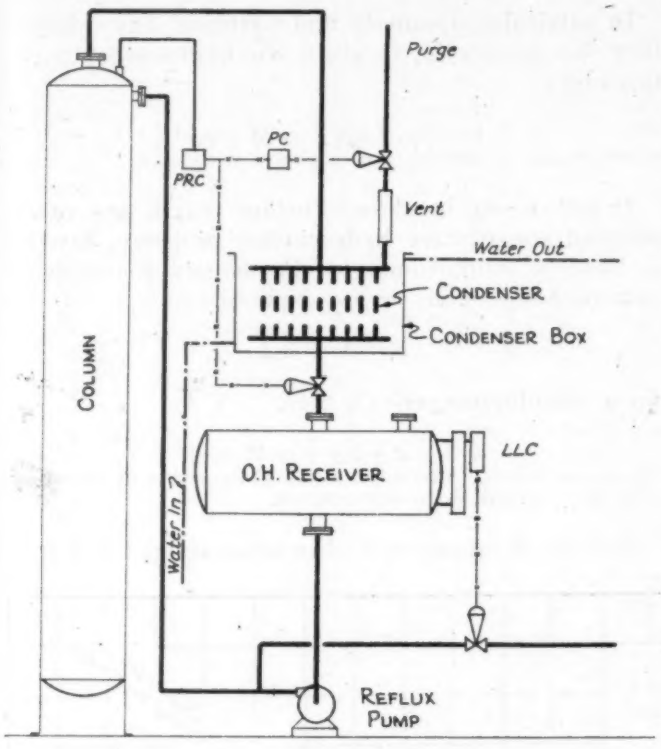
With a properly-designed condenser, the pressure controller need have only proportional control, as a narrow throttling range is required. Automatic reset is not necessary. However, as the sojourn time of the water increases, it will increase the time lag of the system; consequently, the controller will require a wider throttling range and will need automatic reset to compensate for the load changes. The results obtained by using a wide throttling range would not be satisfactory for precision-fractionation towers because of the length of time required for the system to recover from an upset.

It would be impossible to use this control system, for instance, if we were using a condenser box with submerged tube sections. There would be a large time lag in the system due to the large volume of water in the box. It would take quite a while for a change in water-flow rate to change the temperature of the water in the box and finally the condensing rate.

In the presence of such unfavorable time lags, it becomes necessary to use a different type of control system. This type of control system permits the

water rate to remain constant and controls the condensing rate by controlling the amount of surface exposed to the vapors. This is done by placing a control valve in the condensate line and modulating the flow of condensate from the condenser. If the pressure were dropping, the valve would cut back on the condensate flow, causing it to flood more tube surface and, consequently, reducing the surface exposed to the vapors. The condensing rate is reduced and the pressure tends to rise. It is suggested that a by-pass valve be installed to vent the inerts from the top of the condenser, if it is thought that there is a possibility of them building up and blanketing the condensing surface.

This system will probably require automatic reset in the controller, depending upon the time lag in the condensing system.



Type 3, Case C

Case C. Mixed Inerts and Vapor (Overhead Product Desired as a Liquid)

This case is similar to Case B, but the problem is complicated by a higher percentage of inert gases.

The inerts have to be removed or they will accumulate and blanket off the condensing surface, and you will lose control of the fractionator pressure.

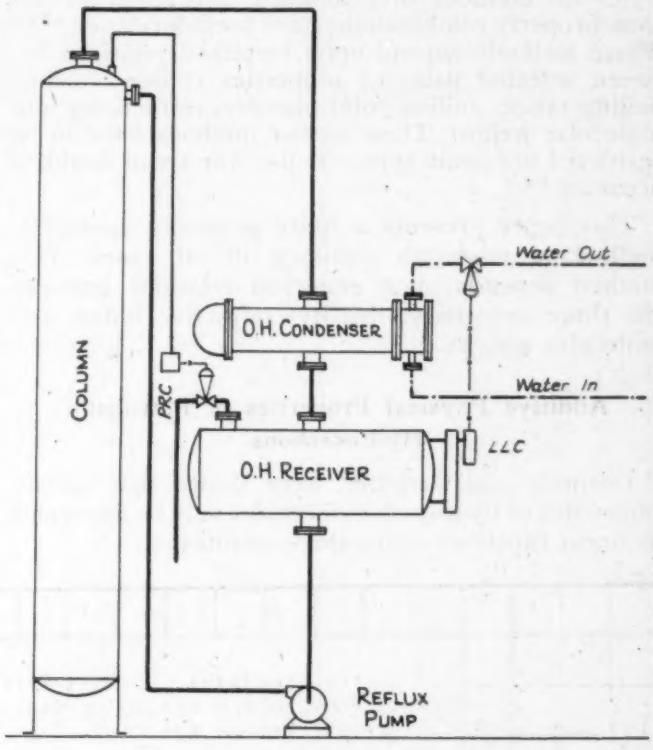
The simplest method of handling this problem is to bleed off a fixed amount of gases and vapors to a lower pressure unit, such as an absorption tower, if it is present in the system. If an absorber is not present, it would be possible to install a vent condenser to recover all the condensable vapors possible from this purge stream.

It is recommended that the fixed continuous purge be used wherever economically possible; however, when this is not permitted, it is possible to modulate the purge stream. This might be desirable when the amount of inerts coming to the tower are subject to wide variation over a period of time.

As the inerts build up in the condenser, the pressure controllers will tend to open up on its control valve to maintain the proper rate of condensation. This is done by a change of air loading pressure on the diaphragm control valve. This air-loading pressure could also be used to operate a purge control valve, as it passed a certain operating pressure. This could be done by means of a calibrated valve positioner or a second pressure controller.

Case D. Mixed Inerts and Vapor (Overhead Product Desired as a Vapor)

In this case the overhead product is removed from the system as a vapor and, consequently, the pressure controller can be used to modulate this flow of vapor as it is a major factor, and the system will respond to changes in its flow.



Type 3, Case D

A level controller is installed on the overhead receiver to control the cooling water to the condenser. It will condense only enough condensate to provide the column with reflux.

Here again this control system depends upon having a properly designed condenser in order to operate satisfactorily. The condenser requires a short sojourn time for the water as in Case B.

If the condenser is improperly designed for cooling-water control, it is recommended that the cooling-water flow be left at a constant rate and the level controller control a stream of condensate through a small vaporizer and mix it with the vapor from the pressure-control valve.

This article has been an attempt to classify the different pressure-control problems and to prescribe a recommended system of control for each. Some of the control systems will give better control than the others, but the choice of control system depends upon the mechanical design of the equipment. Therefore, by remembering this before the equipment is designed, it should be possible to design equipment that will use the more satisfactory control system.

Estimation of Hydrogen Content of Gasoils

CLYVE ALLEN
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AN ESTIMATE of the hydrogen content of a gasoil is useful for various purposes; e.g., prediction of calorific value, oil-type classification, and checking the results of combustion analysis.

Several methods of estimating hydrogen content from property combinations have been developed.[1,2,3,4] These methods depend upon empirical relations between selected pairs of properties chosen among: boiling range, aniline point, density, refractivity and molecular weight. These earlier methods have to be restricted to certain types of oils,[1,2] or are of doubtful accuracy.[3,4]

This paper presents a quite generally applicable method of moderate accuracy in all cases. This method depends upon empirical relations between the three properties: density, refractive index, and molecular weight.

Additive Physical Properties of Petroleum Hydrocarbons

Deanesly and Carleton[5] have shown that certain properties of hydrocarbon mixtures may be expressed as linear functions of the three quantities:

y = hydrogen content, percent by weight.
$1/M$ = reciprocal of molecular weight.
h = unsaturation, expressed as grams of hydrogen which would be taken up by completely hydrogenating 100 grams of oil.

In particular, Deanesly and Carleton[5] have shown that the density, d, is given for hydrocarbon mixtures by

$$1/d = a_1 + b_1 y + c_1/M + e_1 h$$

where a_1, b_1, c_1, and e_1, are empirical constants.

It may easily be shown further that if any other selected constitutive hydrocarbon property, say N, is linearly proportional to the density for each of various homologous series, expressed as

$$N = A_1 + B_1 d$$

for a homologous series i, then

$$N/d = a_2 + b_2 y + c_2/M + e_2 h$$

(a_2, b_2, c_2, and e_2, empirical constants) by virtue of the interrelation of y and M for homologues.

For any homologous hydrocarbon series Cn H_{2n} +

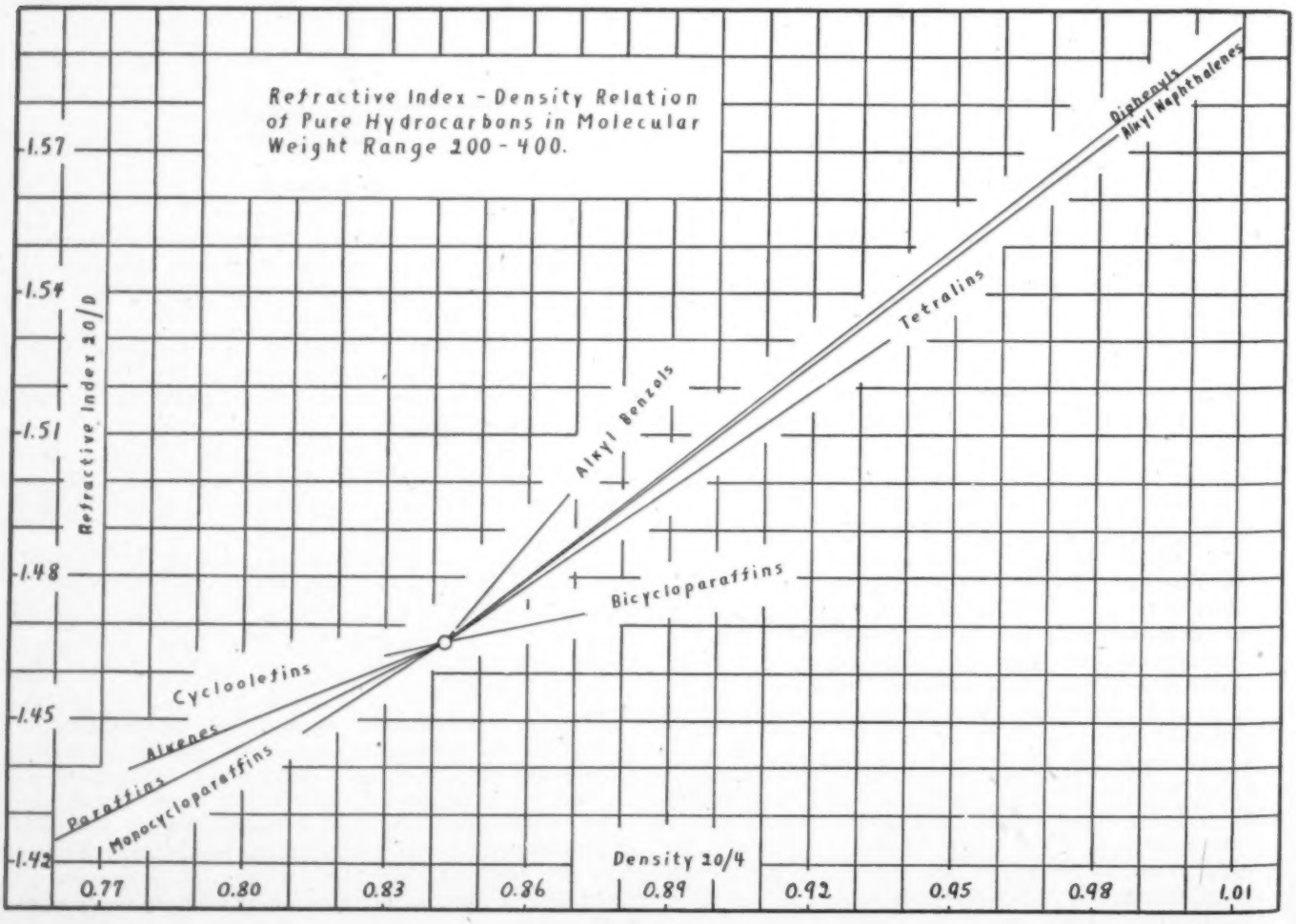

FIGURE 1

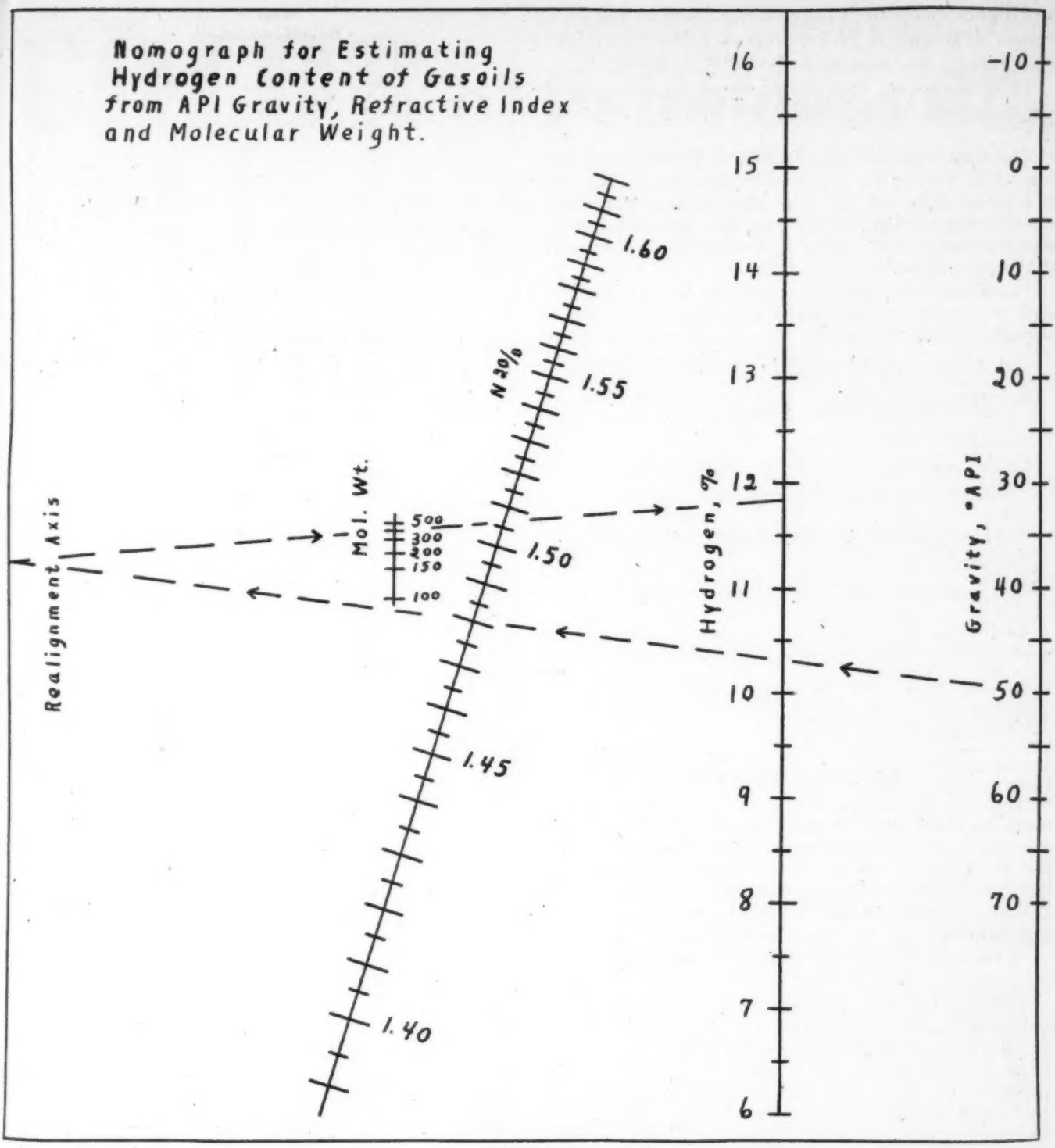

FIGURE 2

x (where n and x have their usual significance[6]), the hydrogen content may be expressed as

$$y = 14.373 + 86.312\ x/M,$$

for the atomic weight of carbon taken as 12.01 and that of hydrogen as 1.008. Also[6]

$$h = 201.6z/M,$$

where z is the number of double bonds per molecule.

The empirical constants are then related by

$$A_i = \frac{86.312\ xb_2 + c_2 + 201.6\ ze_2}{86.312\ xb_1 + c_1 + 201.6\ ze_1},$$

$$B_i = a_2 + 14.373\ b_2 - A_i(a_1 + 14.373\ b_1),$$

for each homologous series i.

It is another consequence of the interrelation of y and M for each homologous series that the additive functions may be expressed:

$$1/d = a_1 + 14.373\ b_1 + \frac{86.312\ xb_1 + c_1 + 201.6\ ze_1}{M}$$

$$N/d = a_2 + 14.373\ b_2 + \frac{86.312\ xb_2 + c_2 + 201.6\ ze_2}{M}$$

Evaluation of Refractivity Constants

The present work has been concerned with the refractive index as an additive property; identifying N as the refractive index.

To evaluate the empirical constants, all the pure hydrocarbon data collected by Doss[7] for 9-carbon

and higher compounds have been plotted as 1/d 20/4 versus 1/M and N_D^{20}/d_4^{20} versus 1/M, correcting[8] data given a few degrees from 20° C. to 20° C.

These data were then extrapolated for each homologous series to common points of intersection at $M = \infty$.

The data were all then replotted, Figure 1, in the form N_D^{20} versus d_4^{20}. From this plot, sets of A's and B's were obtained for the nine series: paraffins, monocycloparaffins, bicycloparaffins, alkenes, cyclomonoolefins, alkyl benzols, tetralins, alkyl naphthalenes, and diphenyls.

From the nine sets of A's and B's, the a's, b's, c's, and e's were calculated by the method of least squares, giving:

$$1/d\ 20/4 = -0.2097 + 0.0972y + 8.81/M + 0.0573h$$

$$\frac{N_D^{20}}{d_4^{20}} = 0.2087 + 0.1066y + 8.26/M + 0.0733h$$

From these equations, h was eliminated to give:

$$y = 27.085 + 72.614/d - 170.45/M - 56.818\ N/d$$

Hydrogen Content Calculation for Gasoils

The equation

$$y = 27.085 + 72.614/d - 170.45/M - 56.818\ N/d$$

$(d = d_4^{20},\ N = N_D^{20})$

was tested on data available in the literature, Tables 1, 2, 3, 4. With a few exceptions, the hydrogen content was calculated accurate to 0.7 percent; average accuracy was 0.3 percent.

Practical Application

It should be noted that a molecular-weight estimate is sufficient for applying the calculation. An error of as much as 25 in molecular weight is within the accuracy of the equation, hence an actual molecular-weight determination is not called for.

For convenience, the hydrogen-content equation has been reduced to a nomogram, Figure 2, in terms of N_D^{20} and API gravity, the latter converted[9] from d_4^{20}.

In using Figure 2, the gravity and refractive-index values are connected by a straightedge and the intersection marked on the realignment axis. The straightedge is then shifted to connect the mark on the realignment axis and the molecular weight, the hydrogen content is then read off. The dashed example represents an oil of gravity 50°, $N^{20}{}_D$ 1.4800, molecular weight 400 and hydrogen content 11.8 percent.

TABLE 1

Gasoils—Kreulen[10]

No.	N_D^{20}	d_4^{20}	M	y	y Calc.	Error
1	1.5377	0.9310	180	9.82	10.29	+0.46
2	1.4881	.8889	215	12.58	12.86	+ .28
3	1.5034	.9136	244	12.08	12.37	+ .29
4	1.4695	.8473	192	13.05	13.37	+ .32
6	1.4776	.8605	227	12.89	13.16	+ .27
5	1.4741	.8522	216	13.02	13.22	+ .20
11	1.4894	.8709	251	12.58	12.62	+ .04
7	1.4722	.8511	217	13.08	13.34	+ .26
8	1.4758	.8496	236	13.04	13.12	+ .08
9	1.4562	.8168	198	13.68	13.82	+ .14
10	1.4781	.8387	233	13.44	12.79	− .65
1-Hyd	1.4641	0.8528	184	13.72	13.76	+0.04
2	1.4725	.8719	218	13.47	13.63	+ .16
3	1.4814	.8896	261	13.33	13.44	+ .11
4	1.4539	.8279	200	14.11	14.17	+ .06
6	1.4624	.8462	240	13.89	14.00	+ .11
5	1.4565	.8309	226	14.16	14.05	− .11
11	1.4629	.8433	261	14.06	13.98	− .08
7	1.4591	.8380	234	14.02	14.07	+ .05
8	1.4517	.8186	235	14.37	14.31	− .06
9	1.4450	.8051	207	14.51	14.47	− .04
10	1.4518	.8187	228	14.37	14.26	− .11

TABLE 2

Lube Oil Extracts—Mair et al[12]

No.	N_D^{20}	d_4^{20}	M	y	y Calc.	Error
B-12	1.5971	1.0335	308	9.19	9.02	−0.17
16	1.5804	1.0135	318	9.91	9.60	− .31
19	1.5671	0.9977	326	10.28	10.10	− .18
C-1	1.660	1.0795	303	8.23	6.42	−1.81
7	1.6208	1.0535	318	8.87	8.07	−0.80
13	1.5930	1.0285	330	10.07	9.17	− .90
20	1.5641	0.9944	347	10.46	10.21	− .25
26, 7	1.5344	.9595	372	11.30	11.44	+ .14
30	1.5234	.9438	384	11.76	11.87	+ .11
33	1.5130	.9265	390	12.03	12.24	+ .21
35	1.5075	.9159	393	12.21	12.41	+ .20
37	1.5012	.9031	401	12.50	12.62	+ .12
res	1.4730	.8595	420	13.97	13.78	− .19
E-1	1.6319	1.0775	367	8.69	7.96	− .73
25	1.5229	0.9465	456	12.12	12.01	− .11
B-12-Hyd	1.5019	0.9326	314	12.81	12.90	+0.09
16	1.5019	.9307	324	12.84	13.89	+1.05
19	1.5010	.9279	329	12.94	12.91	−0.03
C-1	1.5063	.9416	309	12.75	12.76	+ .01
7	.....	.....	...	.....	.....	.....
13	1.5066	.9424	341	12.70	12.80	+ .10
20	1.5024	.9315	353	12.88	12.91	+ .03
26, 7	1.4966	.9171	376	13.10	13.09	− .01
30	1.4928	.9082	384	13.22	13.20	− .02
33	1.4887	.8979	393	13.38	13.32	− .06
35	1.4842	.8872	396	13.53	13.45	− .08
37	1.4818	.8790	402	13.68	13.49	− .19
res	1.4716	.8587	420	14.05	13.87	− .18
E-1	1.5115	.9501	367	12.68	12.66	− .02
25	1.4939	.9082	455	13.29	13.21	− .08

TABLE 3

Blends—Deanesly and Carleton[6]

No.	N_D^{20}	d_4^{20}	M	y	y Calc.	Error
AAAA	1.5451	0.9679	263	10.74	10.78	+0.04
AAAB	1.5214	.9309	264	11.64	11.58	− .06
AABB	1.4995	.8969	269	12.48	12.42	− .06
ABBB	1.4794	.8651	271	13.35	13.23	− .12
BBBB	1.4606	.8356	275	14.20	14.04	− .16
BBBC	1.4919	.8801	304	13.05	12.53	− .52
BBCC	1.5271	.9304	316	11.89	11.34	− .55
BCCC	1.5650	.9842	333	10.74	10.00	− .74
CCCC	1.6088	1.0460	346	9.49	8.62	− .87
CCCD	1.5735	1.0012	361	10.61	9.85	− .76
CCDD	1.5407	0.9590	380	11.67	11.08	− .59
CDDD	1.5129	.9233	386	12.59	12.19	− .40
DDDD	1.4835	.8875	392	13.65	13.47	− .18
DDDA	1.4976	.9048	356	12.96	12.81	− .15
DDAA	1.5126	.9247	317	12.22	12.13	− .09
DAAA	1.5279	.9452	295	11.51	11.49	− .02

TABLE 4

Virgin and Cracked Gasoils—Allen and Duckwall[13]

No.	N_D^{20}	d_4^{20}	M (est.)	y	y Calc.	Error
A	1.4904	0.8601	200	12.26	12.21	−0.05
B	1.4775	.8554	248	13.40	13.14	− .26
C	1.4962	.8708	200	12.29	12.00	− .29
D	1.4812	.8629	285	13.64	13.11	− .53
E	1.5128	.9034	236	12.05	11.59	− .46
F	1.5388	.9384	220	10.79	10.52	− .27
G	1.5152	.9017	208	11.41	11.32	− .09
H	1.4702	.8350	170	13.35	13.01	− .34
I	1.4584	.8155	153	13.47	13.40	− .07

REFERENCES

[1] Vlugter, J. C., Waterman, H. I. and van Westen, H. A., J. Inst. Petr. Techn. **18**, 735 (1932); **21**, 661 (1935).

[2] Cauley, S. P., and Delgass, E. B., Oil and Gas J. **45** (12), 166 (1946).

[3] Sweeny, W. J., and Voorhees, V., Jr., Ind. Eng. Chem. **26**, 195 (1934).

[4] Watson, K. M., Nelson, E. F., and Murphy, G. B., Ind. Eng. Chem. **27**, 1460 (1935).

[5] Deanesly, R. M., and Carleton, L. T., J. Phys. Chem. **46**, 859 (1942).

[6] Deanesly, R. M., and Carleton, L. T., Ind. Eng. Chem., Anal. Ed. **14**, 220 (1942).

[7] Doss, M. P., "Physical Constants of Principal Hydrocarbons," The Texas Co. (1939).

[8] Lipkin, M. R., and Kurtz, S. S., Jr., Ind. Eng. Chem., Anal. Ed. **13**, 291 (1941).

[9] Ward, A. L., and Kurtz, S. S., Jr., Ind. Eng. Chem., Anal. Ed. **10**, 559 (1938).

[10] Kreulen, D. J. W., J. Inst. Petroleum Tech. **23**, 253 (1937).

[11] Mair, B. J., Willingham, C. B., and Streiff, A. J., J. Research Natl. Bur. Standards **21**, 565 (1938).

[12] Allen, C. C., and Duckwall, H. W., Petroleum Refiner **24**, 45 (1945).

COLOR of Petroleum Oils

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COLOR determination is a routine duty of almost every petroleum laboratory. Although color has little, if any, relation to the quality of the product, it is and will continue to be for years to come, one of the important sales requirements and a convenient method for controlling plant operations.

Colors of oils may be investigated in transmitted or in reflected light. The present article deals with the first method of taking colors which is the normal laboratory procedure.

Many difficulties are encountered in practice in expressing the color of an oil in some standard unit. Different observers may disagree widely on commercial instrument readings, and assignment of a color value to an oil sample often is arbitrary. This arises from the complex nature of color and the impossibility of expressing it on a simple scale which would be easy to interpret.

In studying color the existence of two different concepts of this phenomenon should be realized. The physical concept embraces such well known factors as wave length and energy and refers to the source from which the color originates. The subjective concept deals with the effect of these physical stimuli on our vision. For instance, the same sensation of green to the eye may be produced by a wave length within the green range of the spectrum or by a proper combination of wave lengths which independently produce sensations of blue and yellow. On the subjective scale of colors the two sensations are identical although the physical stimuli are entirely different. This example illustrates that the principles on which the physical and subjective color scales are based cannot be the same.

As it was already mentioned the physical concept of color involves wave length and light energy. The visible spectrum includes wave lengths ranging from approximately 392 mμ to about 757 mμ.

1μ (micron) = 1,000 mμ (milli-microns) = 10,000 Å (Ångström units) = 1,000,000μμ (micro-microns) = 0.0001 centimeters.

The subjective concept of color is considerably more complicated. The color is perceived by the human eye as a single sensation but this sensation cannot be expressed without reference to the three distinct attributes: brilliance, hue and saturation. These attributes of color are defined by the American Optical Society[1] as follows:

Brilliance is that attribute of *any* color which may be classed as equivalent to some member of a series of grays ranging between black and white.

Hue is that attribute of *certain* colors which differ characteristically from the gray of the same brilliance and which permits them to be classed as reddish, yellowish, greenish of bluish.

Saturation is that attribute of *all colors possessing a hue,* which determines their degree of difference from a gray of the same brilliance.

These attributes of color as applied to petroleum products are described below.

Brilliance

Colors which have a dissimilar hue, such as blue and red, or green and yellow, can be compared on the basis of their relative brilliance or brightness, i.e., color intensity, as they appear to the human eye. Similarly individual colors can be matched with respect to their brilliance to some shade of gray thus establishing a uniform scale of measurement. This requires definition of black and white, the two extreme points on the scale.

Black is easily defined because it means complete absence of color. However, definition of white is more difficult and involves establishment of some arbitrary standard. This standard white source of light is generally accepted as the average noonday sunlight at a latitude of 39° (Washington, D. C.) and corresponds approximately to a black body radiation at 5000° K.

Colors intermediate between black and white are grays of different intensities, depending on the amount of light energy which they represent. However, the response of the eye is not directly proportional but varies as the square of the amount of energy. This is shown in Table 1 which was compiled on the basis of a large number of experiments conducted with persons possessing normal vision.

Thus the response of the eye to 1 percent of light energy on the low intensity side of the scale is the same as that to 19 percent on the high intensity side.

Instead of brilliance its reciprocal or color intensity may be employed for purposes of comparison. This is often more convenient for expressing visual reactions. For instance, a color is defined as being so

TABLE 1

Response of Human Eye to the Amount of Energy Present in a Source of Light

Relative Eye Response	Color	Light Energy Present Percent
0	Black	0
1	Various	1
2	x	4
3	shades	9
4	x	16
5	x	25
6	of	36
7	x	49
8	x	64
9	gray	81
10	White	100

many times darker than another color or an arbitrary chosen standard rather than the reverse.

Hue

Hue is a considerably more complicated phenomenon than brilliance. White light as defined under the discussion of brilliance may be resolved into a number of bands possessing different hues by passing it through a prism. Sensations of violet, blue, green, orange and red as well as a number of intermediate shades will be obtained. Furthermore, for equal amounts of light energy present in each of the narrow bands, green will appear much more intense than the other colors because the eye is more sensitive to wave lengths of 5000 to 6000 Ångstrom units than to other wave lengths. Figure 1 shows the change in the response of human eye to various wave-lengths, i.e., colors, assuming that the quantity of energy present remains equal.

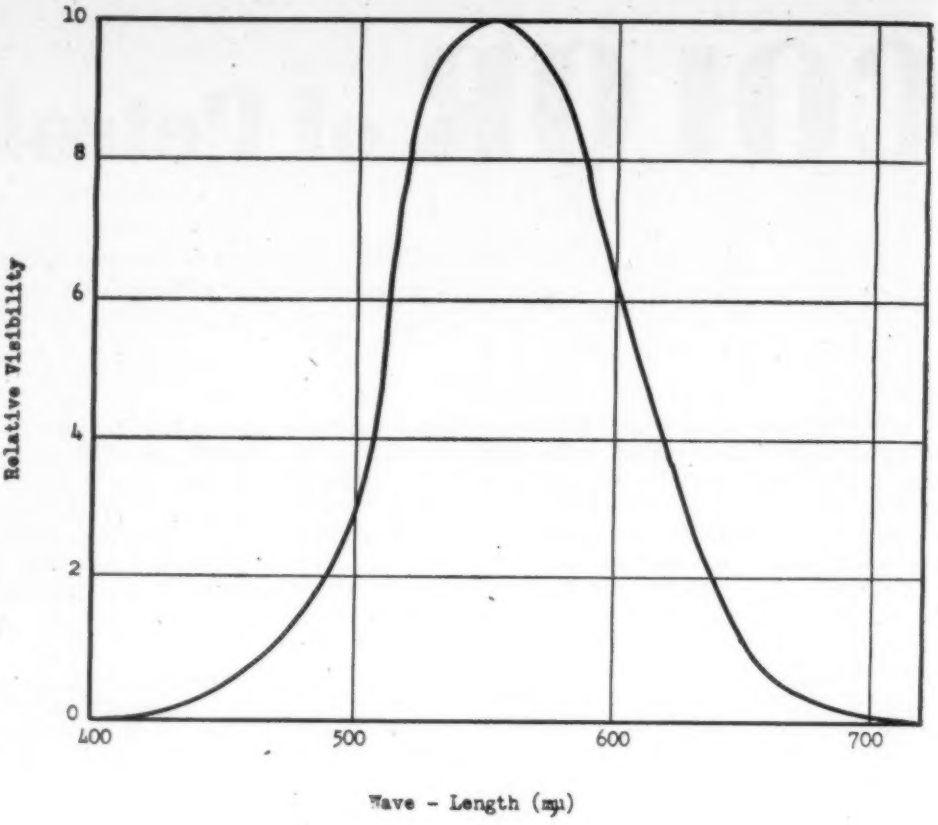


FIGURE 1
Visibility of Monocromatic Radiation.

If all colors are mixed together in proportions corresponding to those found in white light the sensation is white or gray for the reasons already explained. However, if these quantities are out of balance, the color will have a hue. Assuming that the visible spectrum is divided into three equal parts according to the wave-lengths the third corresponding to the shortest wave-length will appear as blue-violet, the middle portion as green and the last portion as orange-red. These three primary colors may be recombined in different proportions to produce all kinds of hue sensations and are known, for this reason, as additive colors. Other combinations of primary colors are possible. However, the extreme difficulties encountered in reproducing these colors in pure state prevents the use of this method in color-measuring schemes.

Subtractive colors are much more convenient for practical applications. They are obtained by removing from white light the primary colors. If all three primary colors are absent the sensation is black because no visible wave-length is present. If the first third corresponding to the shortest wave-length is absent (violet-blue), the sensation is yellow, if the middle portion is removed (green), the sensation is pink (magenta), and if the last third is removed (orange-red), the sensation is blue-green. Any hue may be secured by subtracting these colors in various proportions from the white light.

Colors of petroleum oils usually are determined by permitting white light to pass through the sample under investigation. These colors are, therefore, subtractive. The first wave-lengths absorbed are at the violet end of the spectrum. For darker oils the absorption band expands progressively towards the red end. The hue of the oil thus changes from pale yellow to deep yellow, orange and red.

The hue may be dull or bright depending whether a certain amount of gray is or is not mixed with it. Two oils may have the same hue but appear different depending on the quantity of gray present. The lack of saturation should be ascribed to the presence of asphaltic bodies which absorb evenly a certain proportion of white light passing through the oil. Well-refined Pennsylvania oils are examples of oils possessing high saturation and are brilliant in appearance and pleasant to the eye. On the other hand, lightly-refined Coastal oils containing asphalt appear muddy and dull although their hue may be the same as that of the Pennsylvania oils.

Saturation

The problem of determining the degree of saturation is further complicated by the differences in the eye response to the gray factor. When an oil sample is examined in a thin layer the eye responds primarily to the hue. However, as the thickness of the oil layer increases the effect of the gray becomes more pronounced. For this reason two oils may look alike when they are inspected in thin films, while they may appear entirely different in thick layers.

Color Measurements

The above discussion shows that the color of an oil cannot be expressed as a single unit but should be defined in terms of its three attributes, namely brilliance, hue and saturation. Unfortunately this method of reporting colors is impractical and even if it were adopted few, if any, persons would be able to visualize them and to arrive at necessary comparisons by merely glancing at the laboratory figures. For this reason the simplified schemes for reporting colors of petroleum oils were adopted by the industry. Likewise, as it may well be expected, none of these schemes is entirely satisfactory and no comprehensive method can be developed for translating

colors secured by one of such methods into some other units. Color conversion tables for readings secured by the individual instruments are at the best only approximate and represent certain averages subject to large deviations.

Colorimeters

Majority of the commercial instruments are constructed assuming the validity of Beer's law for this type of measurement. The law states that for equal intensities of transmitted light the concentration of coloring matter is inversely proportional to the thickness of the absorbent layer.

Beer's law was developed for a monochromatic source of light and is not strictly applicable to petroleum colorimeters which employ with very few exceptions a white light for illumination purposes. As it was already mentioned, the response of the human eye varies with the wave-length. This means that for substances capable of absorbing several wave-lengths the integrated curve will not obey the law. However, oils of relatively light color have a good transmission in the green portion of the spectrum and Beer's law may be applied to them with a reasonable degree of accuracy. For oils of dark colors or for the so-called "muddy" oils considerable deviations from the law may be expected. This explains the reasons for somewhat contradictory statements found in the literature with respect to the applicability of Beer's law to petroleum-color measurements. In general, however, the law holds with a greater degree of accuracy than can be expected from the above considerations.

Commercial colorimeters vary widely with respect to the principles applied in their construction. Most of them use arbitrary color scales but a few attempts were made to report the so-called "true" colors which are more or less additive. The impossibility of developing such a scale has been brought up in the previous discussions although some approximations for limited color ranges are possible.

Most of the colorimeters report colors as a single figure. This requires on the part of the operator that he arrive at a certain reasonable balance between the various attributes of color, particularly brilliance and hue. In arriving at this balance each individual operator may be well capable of reproducing his own readings but at the same time disagree with the readings of some other equally capable operator. This will depend on the relative stress laid upon brilliance and hue by the two observers. For the same reason, and strange as it may seem, the color-blind persons are more capable of reproducing color readings than persons with normal vision. They are in a better position to compare colors with respect to their brilliance while the usual deviations in hue between the sample under investigation and the standard do not interfere with their work.

Instruments commonly used for measuring colors of petroleum oils are briefly described below.

Saybolt Chromometer[2] is designed for measuring colors of light petroleum products, such as gasoline, kerosine, perfumery or medicinal oils, and waxes. It consists of two vertical glass tubes 20 inches long which are illuminated from the bottom by the light reflected from a mirror. A prismatic optical head provides a circular field of vision, the two halves of which are illuminated by the oil sample and by the color standard respectively. An artificial daylight lamp is used as the light source in preference to daylight in order to avoid possible variations in intensity depending on weather conditions. One tube is filled with oil the color of which must be determined. A colored disc is placed at the bottom of the other, empty, tube and the oil depth in the first tube is adjusted so as to match the color of the disc. The height of the oil is recorded and changed to the color shade using special tables. For darker-colored oils double discs are employed.

This colorimeter embodies several difficulties from the operator's viewpoint. The hue of the discs does not necessarily match the color of the sample. Moreover variations in the height of the oil column result in the differences in readings for samples possessing a considerable "gray" factor, i.e., the degree of color saturation or transparency. Oils frequently are encountered which give a double reading, one when a single disc and another when a double disc is employed. However, because of the light color of products normally charged to this colorimeter, the difficulties encountered generally are less pronounced than with other instruments, although they cannot be overlooked.

The Tag-Robinson Colorimeter[3] is designed for measuring colors of lubricating oils. It operates on the same principles as the Saybolt Chromometer with the exception that the height of the oil in the tube is adjusted by means of a movable piston immersed in the oil. Three colored-glass discs are employed as standards. Difficulties arising in operating this colorimeter are similar to those described in connection with the Saybolt Chromometer and need not be repeated.

The Lovibond Tintometer[4] is used for recording colors of all types of petroleum products including gasoline, kerosine, lubricating oils and waxes. The instrument consists of a covered box divided longitudinally by a non-transparent partition. The oil to be examined is poured into a cell of fixed length. This length may vary, however, depending on the color of product under examination. The thickness of this cell may be somewhere between ¼ and 2 inches for lubricating oils and 18 to 20 inches for gasolines and kerosines. Cells of intermediate sizes also are employed occasionally.

The color of the fixed layer of oil is matched against the proper combination of colored glasses. The color intensity of each glass is adjusted so as to represent a certain fraction or multiple of the color intensity of another glass. The color of the sample is thus reported as a number which represents the combined thickness of all glasses employed and expressed in terms of color units.

The original instrument is equipped with three series of glass: 200 Red, 510 Yellow and 1180 Blue. These three basic colors when used in proper combinations permit exact matching of the color of the sample. Each series consists of 155 glasses of different degrees of density of the respective colors, or a total of 465 glasses, but for most purposes a complete collection of glasses is superfluous.

Although this system of color measurement has a good theoretical foundation it requires that the color of an oil is reported in terms of several basic colors. Even an expert in colorimetry can hardly be expected to compare the relative colors of samples when reported by means of this system. For petroleum work a special, 500 Amber, series of glasses was developed, therefore, which matches more or less closely the color of oils without resorting to the use of other series.

This simplified Lovibond system of reporting colors is again open to several objections. The

Amber series of colored glasses does not match necessarily the hue of the oil. The use of thin cells results sometimes in readings which are reverse to those that would be secured if the samples were examined in thick layers, such as in quart or even four-ounce bottles. This is particularly important because oils are sampled in such containers. However, within reasonable limits, and particularly in the light color ranges, the Lovibond colors are additive which simplifies some of the blending problems.

The NPA, ASTM or Union Colorimeter[5] is employed for estimating colors of lubricating oils. It consists of a box which is divided longitudinally by a light-proof partition. Each section has an opening for inserting four-ounce bottles. One of the bottles is filled with the oil under investigation and the other with distilled water. The color of the sample is then matched against the standard color glass discs which are inserted in a slit in front of the bottle filled with water. The color is recorded as the number of the glass disc with which the oil matches best. No relationship exists between the colors of individual glasses which are arbitrary standards.

The method is very crude and permits only relatively rough differentiation between the oil colors. It is subject to the same errors as other methods but is fast and convenient when a high degree of accuracy is unnecessary.

Duboscq Colorimeter with a monochromatic source of light has been recommended for measuring colors of petroleum oils.[6] Although the results obtained are reproducible and the readings are additive, the use of monochromatic light reduces comparisons to only one portion of the spectrum. As oils normally are examined in daylight, this method may lead to confusion.

Photoelectric Colorimeters were adopted recently for measuring colors of petroleum oils. These colorimeters substitute a photoelectric cell for the human eye. Considerable care must be exercised, however, in selecting the cell which must have the same response to various colors as the eye in order to secure comparable results.

Story colorimeter was the first one recommended for this particular purpose.[7] It measures the color brilliance of the oil sample without reference to hue. The Diller colorimeter attempts to determine not only brilliance but also the hue of the oil by employing light filters.[8]

A number of other colorimeters have been proposed at various times and some of them are still in limited use. These colorimeters include those developed by Wilson,[9] Hellige,[10] Stammer[11] and others. Their description and detailed analysis is omitted, however, not only because they are seldom encountered, but also on account of their similarity with the instruments already described.

Blending to Color

Refineries are confronted continually with the color blending problems. Solution of these problems requires that the color of oils is expressed in some additive units. However, the impossibility of developing such color scales has been already demonstrated and for this reason the color blending methods can be only approximate. These methods may be improved considerably by developing suitable relationships for products manufactured at the individual refineries which have a definite source of crude oil supply.

Saybolt colors are blended assuming validity of Beer's law. The height of the oil column is used instead of the reported colors which are quite arbitrary. Necessary corrections are made for the thicknesses of the discs employed. The following table simplifies such calculations.

TABLE 2

Approximate Conversion Table for Saybolt Chromometer Readings to Additive Colors

Saybolt Color	Additive Color	Saybolt Color	Additive Color	Saybolt Color	Additive Color
30	0.0128	12	0.124	−6	0.303
29	0.0142	11	0.132	−7	0.315
28	0.0160	10	0.141	−8	0.328
27	0.0183	9	0.152	−9	0.341
26	0.0213	8	0.158	−10	0.356
25	0.0256	7	0.164	−11	0.372
24	0.0284	6	0.171	−12	0.390
23	0.0320	5	0.178	−13	0.410
22	0.0366	4	0.186	−14	0.431
21	0.0426	3	0.195	−15	0.455
20	0.0476	2	0.205	−16	0.482
19	0.0539	1	0.216		
18	0.0621	−0	0.228		
17	0.0706	−1	0.241		
16	0.0819	−2	0.256		
15	0.0976	−3	0.273		
14	0.105	−4	0.283		
13	0.114	−5	0.293		

Example: Calculate percentages of gasolines of 25 and 12 Saybolt colors in a blend of 16 Saybolt color.

Additive colors corresponding to the above Saybolt colors are found from Table 2. The fraction (n) of the 25-Saybolt-color gasoline in the blend is determined, therefore, from the following equation:

$$0.0819 = 0.0256n + 0.124\,(1 - n)$$

$$n = 0.438$$

The blend should contain 43.8 percent volume of gasoline of 25 Saybolt color and 56.2 percent volume of gasoline of 12 Saybolt color.

Similar approximate conversions of lubricating oil colors to additive colors are presented in Table 3.

TABLE 3

Approximate Conversion Table for Commercial Colorimeter Readings to Additive Colors

NPA Color	Union Color	Tag-Robinson Color	Lovibond Color (¼" Cell)	Additive Color
¼	..	....	....	0.195
½	..	....	....	0.256
¾	..	....	....	0.341
1	G	21	0.4	0.431
1½	H	17.5	1.5	1.5
2	I	12.5	5.5	5.5
2½	J	10.25	10	10
3	K	9.75	14	14
3½	L	9.25	20	20
4	M	8.25	32	32
4½	N	5.75	42	42
5	O	3.50	55	56
6	P	2.25	90	102
7	Q	1.50	135	168
8	R	0.90	200	285

It is of interest to note that on the average, Lovibond colors up to 50 correspond to additive colors. However, at higher values the two colors begin to diverge considerably.

Acknowledgment

The writer would like to express his appreciation to Messrs. J. W. Newton and W. W. Leach for permission to publish this manuscript.

BIBLIOGRAPHY

[1] Optical Society of America. Report of the Colorimetry Committee, 1920-1.

[2] ASTM Designation: D156-38

[3] Tagliabue, C. J., Mfg. Co. Manual for Inspectors of Petroleum

[4] Lovibond, J. W., Light and Color Theories, 1915; Campbell, A., Petroleum Refining, 74-85(1922)

[5] ASTM Designation: D155-39T

[6] Ferris, S. W. and McIlvain, J. M., Ind. Eng. Chem. Anal. Ed. **6**, 23-9(1934)

[7] Story, B. W. and Kalichevsky, V. A., Ind. Eng. Chem. Anal. Ed. **5**, 214-7(1933)

[8] Diller, I. M., DeGray, R. J. and Wilson, J. W. Jr., Ind. Eng. Chem. Anal. Ed. **14**, 607-14(1942); Diller, I. M., Dean, J. C., DeGray, R. J. and Wilson, J. W. Jr., Ind. Eng. Chem. Anal. Ed. **15**, 367-73(1943)

[9] Holde, D., The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes, 130-2(1922)

[10] Hellige, Petroleum **Z. 10**, 725(1914)

[11] Holde, D., The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes, 129-30(1922)

TABLE 1

The Effect of Small Temperature Changes on Viscosity Measurements

OIL	Viscosity at 210° F. in Centistokes	Viscosity at 100° F. in Centistokes	Viscosity at 180° F. in Centistokes	Viscosity at 80° F. in Centistokes	Average Percent Change in Viscosity per 1° F. Change in Temperature Over Range 100-80	Average Percent Change in Viscosity per 1° F. Change in Temperature Over Range 210-180
A.....	4.36	24.95	6.16	41.92	3.4	1.38
B.....	4.36	34.08	6.48	64.95	4.5	1.62
C.....	15.81	176.3	25.68	365.7	5.4	2.1
D.....	15.81	362.2	29.12	957.4	8.2	2.8

Note—The viscosity of water in the neighborhood of 20° C. (68° F.) changes about 2.5 percent per 1° C. or 1.4 percent per 1° F. change in temperature.

A Modern Constant-Temperature Bath

M. R. CANNON and K. J. HEIDRICH
State College, Pennsylvania

THE needs of a research laboratory and of a testing laboratory constantly become more exacting. In all such laboratories constant-temperature baths have a very important bearing on the accuracy of much of the data obtained. For example, viscosity, density and refractive index are but a few properties that require a precise constant-temperature bath for accurate results. Table 1 illustrates the variation in viscosity caused by a temperature change of 1° F. It is evident that the temperature must be controlled very accurately to enable viscosity measurements to be reported to a precision of 0.2 percent.

In order to produce a good constant-temperature bath the following requirements should be met:

1. The temperature should be automatically controlled.
2. The bath should have a high thermal capacity and accommodate many instruments at one time.
3. The bath should be convenient for the workers.
4. Good visibility of immersed equipment should be attained.
5. Little maintenance should be required.
6. The construction should be sturdy and durable for many years of service.
7. Attractive appearance should be incorporated in the design.

In order to meet the foregoing requirements careful consideration of many factors is required. The close control of temperature requires an excellent type of thermo regulator. Three methods may be employed. In the first, a thermopile may be connected to a mirror galvanometer so that a small temperature change will generate sufficient electromotive force to deflect the mirror slightly. A beam of light is focused on the mirror and the reflected beam moves on or off a photosensitive tube which operates the relay circuit to increase or decrease heat supplied to the bath. The second method employs a resistance thermometer into an electronic circuit so designed as to operate a relay by the minute changes in resistance caused by small temperature changes. A third method is to employ a mercury-in-glass thermoregulator so designed that a temperature change of 0.004° F. is sufficient to cause operation of the relay circuit.

Thermal Sensitivity

This last method is by far the simplest and will be discussed in more detail. A thermoregulator should be sensitive to small temperature changes and it should follow such changes rapidly. The necessary amount of mercury for the required sensitivity depends upon the diameter of the capillary in which it moves, due to expansion and contraction, and upon the amount of movement required to make a sharp break with the contact wire. The speed with which the thermoregulator follows temperature changes depends upon the mass of mercury used, the specific heat capacity of mercury, the area available for heat transfer between the mercury and the bath fluid, and the overall coefficient of heat transfer between the mercury and bath fluid. The high density of mercury is a disadvantage, but it has a very low specific heat capacity (0.033 at 20° C.) which is a great advantage. For example, 1 calorie will cause 1 gram of water to change in temperature by 1° C. However, 1 calorie will cause 13.6 grams of mercury to change in temperature 2.2° C.

Fortunately, there is available commercially a mercury thermoregulator costing less than $20.00 which was designed after thorough study of the above fac-

tors, and it rapidly operates on temperature changes of only 0.004° F.

Low Current Flow

Such sensitivity in a thermoregulator can be obtained only by the elimination of sparking at the interface between the mercury and platinum-wire contact. This demands very low current flow in the thermoregulator-relay coil circuit. Such low currents may be obtained by an electronic-type relay of which there are many available—a suitable one is described by Fry and Fenske.[1] However, a well-designed relay coil of high resistance can be made to operate on the necessary small current without the use of any electronic tubes. These relays have been made available commercially recently, and after several months of satisfactory tests we are now using them in preference to the electronic type. They require no tubes and no maintenance and are inexpensive.

For close control of bath temperature it is necessary to have a "fixed" heat and a "variable" heat. The fixed heat is sufficient to keep the bath just below the required temperature, and the variable heat is automatically turned on and off by the thermoregulator acting through the relay. The fixed heat should be variable by means of a transformer, so that it can be readily set at different fixed values for different temperatures.

Insulation

It is advisable to insulate the bath because the lower the rate of heat loss from the bath to the room the closer will the temperature be maintained. By inserting the glass tank within a housing it is possible to place glass-wool insulation around the back and two ends. The front must be unobstructed for good visibility, but it is advisable to place a plate glass window on the front of the housing so that the heat loss is reduced and the bath is protected from varying air currents in the laboratory. It is of great importance to have a non-metallic lid on the bath. The most important area of the whole bath from a heat-loss standpoint is the liquid surface, and yet many laboratories employ uncovered baths. A metallic lid reduces the heat loss by a very small amount because metals are such excellent conductors of heat. A metal lid is also annoying to the operators; when working with the bath at 210° F. the lid is hot enough to burn, and constant care must be exercised. Non-metallic lids are much more satisfactory since they are better insulators than metals. A satisfactory material is transite of ½-inch thickness. Another suitable material is a laminated phenolic plastic such as Synthane, Bakelite, Formica or Dielecto, although some warping will occur after several years of use.

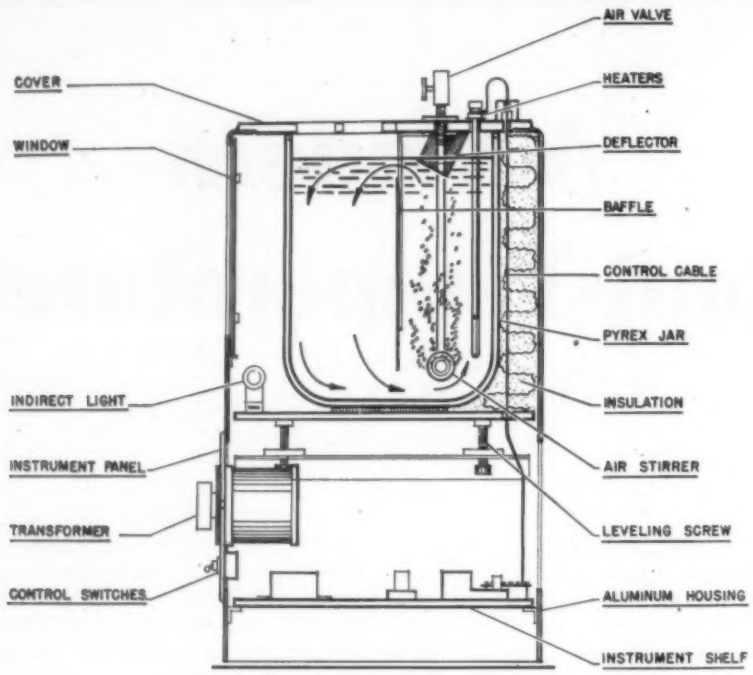


FIGURE 1
Schematic diagram showing assemble arrangement.

Good stirring is essential. This may be accomplished either by means of air diffusion or by an electric stirrer of adequate capacity. Figure 1 shows schematically the method of installing an air diffuser type of stirrer. We have employed such stirring devices for more than 12 years and find them to do an excellent job. The ascending air bubbles lift the water in the rear of the baffle which strikes the deflector plate, forcing the water over the top of the baffle so that the water flows downward in front of the baffle and upward in the rear. The air diffuser is of porous brass pipe so that it is very rugged. Porous ceramic tubes are also suitable but more fragile.

The advantages of stirring by air diffusion are: no moving parts, no maintenance, silent vibrationless operation, and no fire hazard. The disadvantages are that it can be used only to stir water and is limited to satisfactory use at 150° F. or lower. If employed above 150° F. the loss of water due to evaporation makes it necessary for the operator to add water about once each day.

Figure 2 shows the same bath with an electric

stirrer in place. The impeller of the stirrer is behind the baffle so that water flows from front to back both over the baffle and under the baffle, while it flows from back to front at each end of the baffle where adequate clearance is provided.

The baffle serves a useful function in bringing about proper stirring, and also in serving as a good reflector for the indirect fluorescent light shown in Figure 1. Polished stainless steel is used for this purpose with very good results.

The heaters, thermoregulator, and air or motor stirrer are all placed behind the baffle, leaving the front area completely free for inserting instruments or other equipment under test.

There is also adequate room behind the baffle for inserting a copper coil for passing through cooling water when operation below room temperature is desired, or for controlling the temperature of water that is being circulated through a refractometer or other equipment.

The rectangular type of pyrex jar shown, with rounded edges and corners, is much more convenient but more expensive than the conventional cylindrical type. It is worth paying the additional money for this type, since it is much more convenient to work with. The jar shown has a front side approximately 17 inches long and 13 inches high. It is deep enough to permit the insertion of 12 viscometers of Cannon, Fenske, or Ubbelohde type, or other types at one time. One experienced operator can turn out more data per day with this bath than several operators can with less convenient equipment.

A fluorescent light tube approximately 18 inches long is used so that the light is diffused throughout the working part of the bath. The radiant heat from such a 15-watt tube is very small and one can test dark oil samples without danger of having them absorb any appreciable quantity of radiant heat. The light is hidden from direct view, so that no eye strain is imposed. The immersed equipment stands out in such excellent clearness that it is easy to see the meniscus of liquids in tubes of all sizes.

The housing for the pyrex jar and control equipment should be attractive and durable. Aluminum of ⅛-inch thickness is a superior material. It is inadvisable to paint it, because it is sure to be frequently spotted with solvents and oils which will cause the paint to peel off eventually. However, it is a rather simple matter to give the finished aluminum housing a frosted, satin-like finish. This eliminates the scratching that inevitably occurs during fabrication and produces a finish that is beautiful and durable.

The instrument shelf is hidden within the housing. It carries the relay, ballast, starting socket for fluorescent light, binding-post strips, etc. It is accessible by a large opening in the rear or by removing the instrument panel in front.

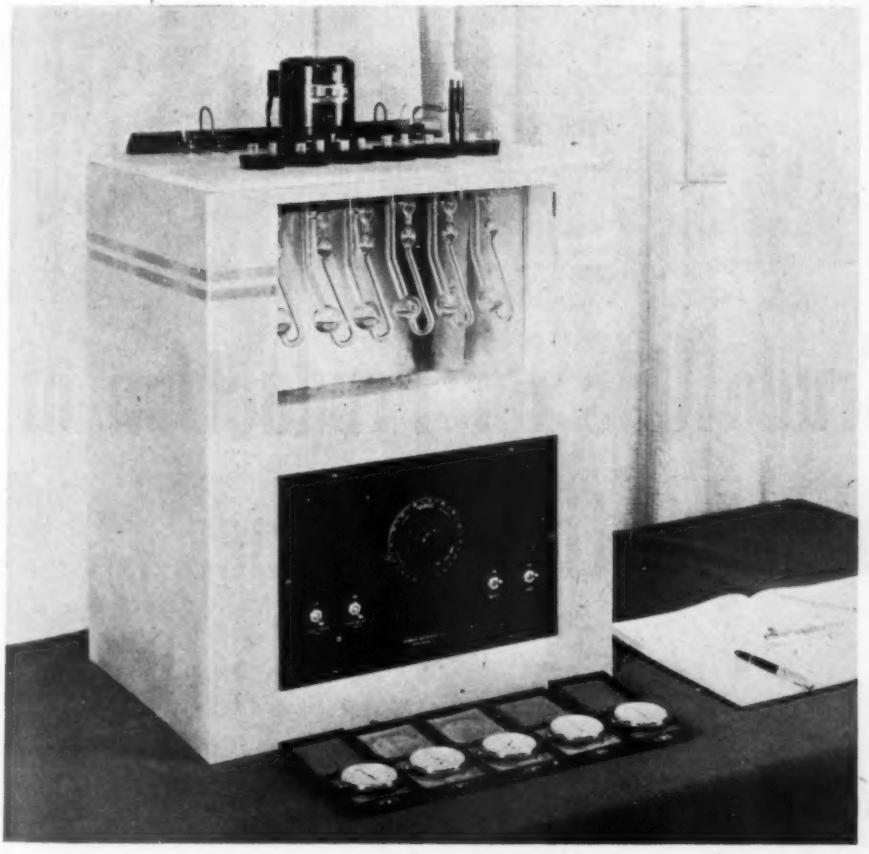


FIGURE 2

Finished bath with some viscosimeters in place. Ample room for 12 viscosimeters is available.

Instrument Panel

The instrument panel is made of a laminated phenolic resin of Bakelite type. It carries all switches and the transformer control. Pertinent information is deeply engraved in the panel and filled with white filler. The transformer is rather heavy and for that reason it is attached to the housing rather than to the instrument panel. The pilot light, which indicates the throwing on and off of the variable heater, is located on and is an integral part of the thermoregulator.

The pyrex jars, although square on top, are not made to exact dimensions. The jar shelf is movable by means of leveling screws to allow for dimension variations and permit obtaining a snug fit between the top of the jar and the under side of the lid. The jar rests on a felt pad which is carried by the jar shelf.

Figure 2 shows the finished bath with some viscometers in place. When operated at 100° F. this bath maintains the temperature to within 0.006° F. It meets all of the requirements specified earlier.

It is advisable to use distilled water as the bath medium up to and including 210° F. The rate of vaporization is not too great at 210° F. with a motor stirrer. In locations where the barometric pressure is low enough to cause boiling of the water at or below 210° F., a suitable quantity of glycerol can be added to the water to elevate the boiling point to 211°F., thus permitting satisfactory operation at 210° F. without boiling.

The authors will be glad to forward more detailed information and sources of supply for the equipment used in this bath.

LITERATURE CITED

[1] Fry and Fenske, Ind. Eng. Chem., vol. 30, page 364 (1938).

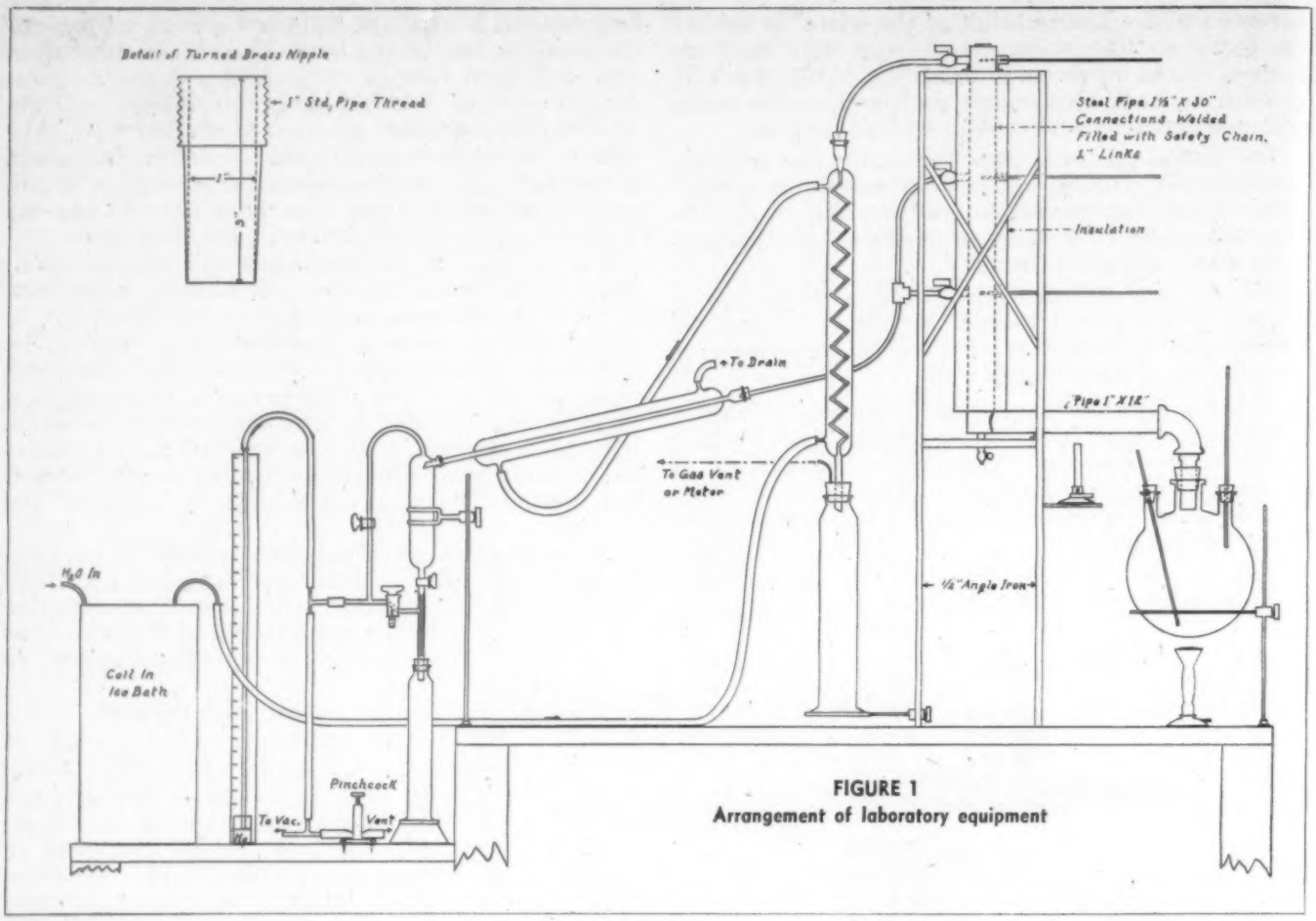


FIGURE 1
Arrangement of laboratory equipment

Evaluation of Crude Oils for Production of Straight-Run Aviation Gasolines

B. G. ADAMS

INCREASING demand for 92- and 100-octane gasoline warrants further investigation by refiners who in the past have concluded that their available crude oil, using their present plant facilities, was unsuitable for the manufacture of these products without the addition of an expensive catalytic or thermal cracking unit.

Also the trend is toward evaluation of crude oil on the basis of its gasoline content rather than the API gravity. Exemplifying the inconsistencies of the gravity as a price yardstick, a 16-gravity Santa Maria, California, crude oil, having a 20 percent gasoline content, has the same market value as a southern San Joaquin valley oil of the same gravity containing only 8 percent gasoline.

While the description of the laboratory apparatus and the procedure for making aviation gasoline, is the primary purpose of his article, the equipment is also well suited for the accurate evaluation of the percent of crude oil constituents which can be separated in the conventional plant steam-atmospheric topping unit.

The first step is to determine whether the crude oil will yield the proper combination of hydrocarbons. This can be done inexpensively in any small laboratory with the arrangement of equipment shown in Figure 1. This is largely self-explanatory with the exception that the inside diameter of the turned brass nipple must be not less than one inch, otherwise, toward the end of the distillation, congestion will occur at this point due to the returning natural reflux countercurrent to the departing vapors. This nipple being turned to a very sharp edge at the lower end, also serves as a hole cutter for the No. 24 cork which fits into the neck of the 3-liter flask. Rubber stoppers are not recommended.

The crude oil from any locality will present its own particular problem, but with small variations the

procedure described here will be the same as for the conditions encountered by the author.

Usually only heavy crude oils contain gasoline whose lead susceptibility is such that the required octane number may be attained with the addition of the permissible amounts of tetraethyl lead. The gasoline stock, or naphtha, extracted from a heavy crude oil requires a certain amount of natural gasoline to bring the distillation range within specifications. However, in the majority of natural gasolines one or both of the following conditions will be found: the end point will be too high, or the initial-boiling point too low, with its accompanying high vapor pressure.

tillation is again started. It is important that the effluent condenser water be kept at from 90° F. to 95° F. to allow the lower-boiling fractions to escape as gas through the vent from the receiver. This gas may be metered and collected in a CO_2 condenser if desired. However, the amount may be estimated because it constitutes almost all of the total distillation loss. The distillation is stopped, as before, when the required Engler end point has been reached. Both distillations are to be repeated until there is a quantity of distillate large enough to permit treatment for sulphur removal, lamp sulphur, Engler, octane number, and lead susceptibility.

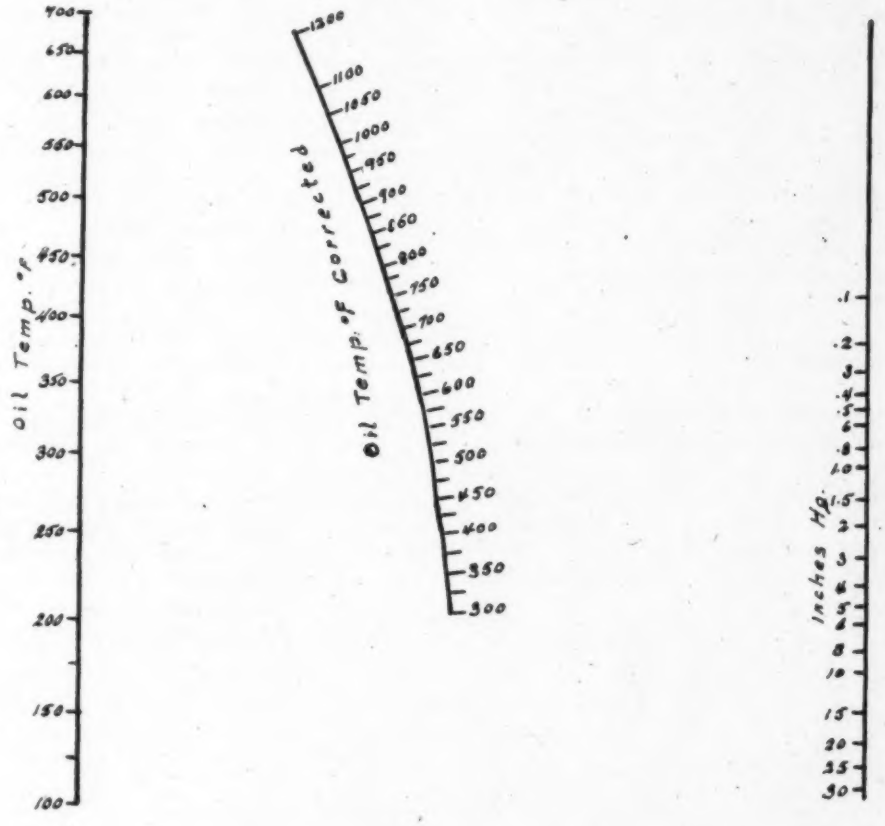


FIGURE 2

The necessary trimming is accomplished in this manner. After the stock of the desired Engler end point, which will be within 5 degrees of the top column temperature, has been separated from the crude oil in the still, it is charged into a clean 3-liter flask. To this is added a small amount of natural gasoline, usually from 5 to 10 percent, the exact percentage to be found by trial. This replaces the crude-oil flask and the dis-

Initial octane number means little, the significant thing being the potential octane number after the gasoline has been leaded. But there are cases, where finding this too was poor, the enterprise was abandoned by the refiner overlooking the deleterious effect of sulphur on the power of tetraethyl lead to raise octane number.[1] The final octane number after leading may be from 3 to 10 whole numbers lower than the possible octane number if the gasoline contains as little as 0.05 percent sulphur.

Selection of the type of apparatus for sulphur

[1] Antiknock Properties of Materials Resulting from Superfractionation of Natural Gasolines, by T. W. Legatski and H. R. Legatski, Petroleum Refiner, Vol. 25, No. 5, May, 1946.

removal, in the plant, depends on the regional characteristics of the sulphur compounds.

If the results of the tests are found favorable the problems relative to plant conversion will, of course, be found different in each refinery. This was accomplished in one 3000-barrel plant with the only major addition to the topping still being a 3 x 60-foot secondary fractionating column. The required amount of natural gasoline may be added either with the crude oil or the reflux into the fractionator. The heavy ends removed as a naphtha, from the bottom of the secondary fractionator, together with the light fractions from the top of the stabilizer, are used to blend into third-grade gasoline. The aviation-base-stock is taken from the bottom of the stabilizer. Heat is furnished by superheated steam reboilers. A 23-plate stabilizer column was already on hand in this instance.

The Laboratory Vacuum Still as an Analyzer of Crude Oil

Two thousand milliliters of the oil to be evaluated is weighed into the 3-neck 3-liter flask. The flask is sealed to the cork with black Permatex. The stopcock on the gasoline outlet at the top of the tower is opened and the stopcocks at the kerosine distillate and gasoil outlets are closed. Cold water is started through the condensers. Fire is applied from the Fisher burner to the side of the flask until the distillation has progressed to the point where all water has been vaporized. Otherwise "bumping" and foaming may occur.

The Bunsen burner is lighted at the same time as the Fisher burner, playing a low fire around the transfer line. This is an important feature of this still and is the reason for the flask being offset from the conventional position directly beneath the tower. It makes possible the distillation of crude oils containing as much as 5.0 percent water without previous dehydration. Any water that may drop back from the tower cannot pass this hot spot to return to the flask with the too-well-known result.

[2] Listed in the laboratory supplies catalog of Braun Corporation.

A helpful hint at this point, is the addition of 2 or 3 grams of magnesium oxide to the charge if the oil is very wet.

When the distillate starts to drop, from the end of the helical tube condenser, the fire should be adjusted so that the drops fall in rapid succession without breaking into a stream. If this rate is not exceeded the Engler end point of the recovered condensate at any time will be within 5° F. of the top tower temperature.

At the end of the gasoline cut, open the stopcock at the kerosine-distillate outlet and close the one at the gasoline outlet. Kerosine distillate of the desired Engler end point, may distill at atmospheric pressure before the oil temperature in the flask reaches the point of destructive distillation. If not the distilling is continued by manipulating the pinchcock at the vent from the vacuum machine. A pinchcock will give finer control than a needle valve. The oil temperature is not allowed to vary greatly after reduction in pressure is started. The pressure must be lowered very cautiously as the boiling point of the oil is approached. a decrease of ¼-inch Hg. beyond this point is sufficient to cause the oil to boil over.

The approximate of the recovered distillates end points, at reduced pressures, will be found from the temperature at the tower outlet corrected on the chart shown in Figure 2. Cuts of about 120 ml. are withdrawn, without breaking vacuum, from the vacuum receiver[2] into the mixing graduate. The volume of these cuts is corrected to 60° F. and recorded. The API gravity and Engler distillation are determined. From this information the required combination of cuts may be mixed to satisfy the specifications sought.

After the kerosine distillate has been extracted the gasoil is taken through the gasoil outlet in the same manner.

When the run is finished it is important, for safety reasons, to allow the fuel oil in the flask to cool to about 150° F. before bringing the system back to atmospheric pressure. The fuel oil is then withdrawn from the flask by siphoning.

Figure 3 is a typical report of crude-oil analysis.

FIGURE 3
Crude Oil Analysis

API Gr. at 60 °F.= 25.8 Sp. Gr.= 0.8996 BS&W = 1.0 percent.
CHARGE 2,000 ml. by wgt.—10 ml. H_2O from dist.= 1,990 ml. net.

Cut No.	From °F.		To °F.		Press. In. Hg.	ml	Percent	Gravity	I.B.P.	10 Percent	50 Percent	90 Percent	End Point
	Oil	Vapor	Oil	Vapor									
1	.....	110	.....	334	29.2	265	13.32	.....	122	185	242	300	340
2	.....	334	550	396	29.2	82	4.12	.....	.....	.....	.....	.....	.....
3	550	.....	560	.....	27¼	62	.....	38.6	.....	.....	.....	.....	.....
4	560	.....	555	.....	25	64	.....	35.8	.....	.....	.....	.....	.....
5	555	.....	555	.....	22½	62	.....	33.8	.....	.....	.....	.....	.....
6	555	.....	565	.....	21	61	.....	32.5	.....	.....	.....	.....	.....
7	565	.....	570	.....	18½	65	.....	31.6	.....	.....	.....	.....	.....
8	570	.....	565	.....	14	61	.....	30.8	.....	.....	.....	.....	.....
9	565	.....	550	.....	6¼	92	.....	29.7	.....	.....	.....	.....	.....

Bottoms S. F. Vis. at 122 = 144 P.M. Fl. = 200+..... 16.1

YIELD:

Product	Combined Cuts	Percent	Gravity	I.B.P.	10 Percent	50 Percent	90 Percent	End Point
Gasoline or naphtha	1, 2	17.44	.....	126	196	270	352	398
Kerosine, Distillate	3, 4, 5	9.47	36.0	392	414	434	468	503
Gasoil or diesel	6, 7, 8, 9	14.02	29.8	496	518	570	620	692
Fuel oil	Residue	57.91	16.1	.....	.....	.....	.....	.....
Fuel oil	.....	S.F. Vis.	at 122=144					
Loss	.....	1.16						
Total	.....	100.00						

Remarks: Fuel oil same as bottoms because no gasoil needed to blend back.

More Gasoline, Less Coke, From New Cat Cracker Design

ORIGINAL design features developed by engineers of Universal Oil Products Company, and proved out in a new type fluid-catalytic-cracking pilot plant, is reported by them foreshadowing substantial advantages to refiners by making the cracking reaction more efficient.

Experimental results indicate that a commercial unit embodying these improvements will produce considerably higher yields of gasoline than are obtained in catalytic-cracking units of conventional design and will substantially reduce the amount of coke which must be burned.

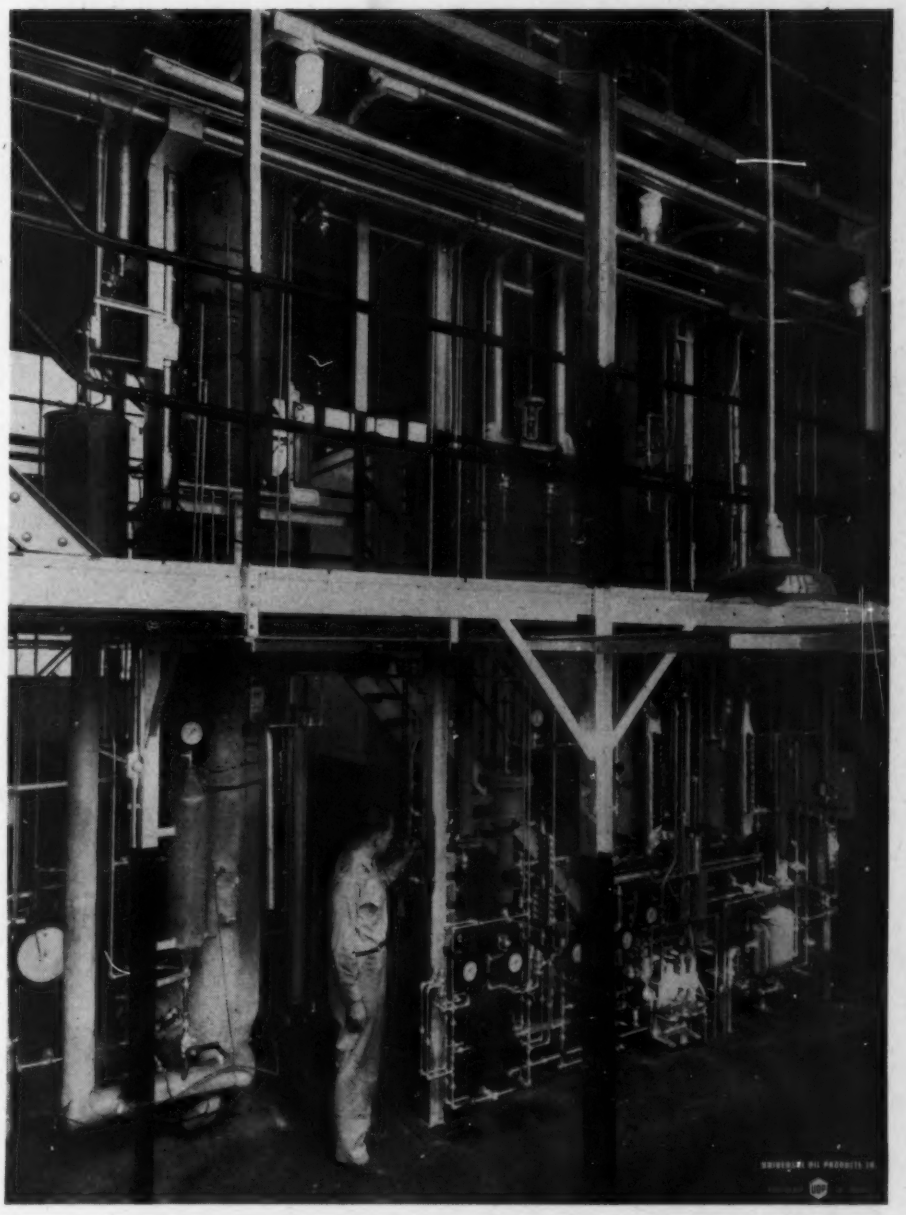
The higher yield of gasoline is mainly accomplished by better utilization of space in reactor and regenerator, and more efficient stripping of adsorbed light fractions from the spent catalyst. Better utilization of space is achieved by the installation of distribution grids of original design in the reactor and regenerator. This design feature minimizes over-cracking and particularly the cracking of catalytic gasoline fractions to gas and coke. The improved stripping is accomplished by the use of an external stripper which allows intimate and efficient contact between the stripping medium, which is steam, and the spent catalyst.

In the new U.O.P. design, coke formation is lessened by two major factors:

1. The more efficient stripping of the spent catalyst which removes gasoline fractions that otherwise would be lost, also removes much of the heavy coke-forming hydrocarbons before the spent catalyst goes to the regenerator.

2. Countercurrent flow of spent catalyst and hot flue gas in the regenerator permits the use of the top zone of the regenerator dense-phase catalyst bed as a "distillation" section. In this section, flue gas at temperatures higher than those prevailing in the stripper, and practically devoid of oxygen, meets the downcoming spent catalyst, serving to distill off much of the heavy hydrocarbons, thus further reducing the formation of coke.

Considerable economy in construction results from reduction in size of reactor and regenerator, which is made possible by more efficient space utilization.



Latest U. O. P. Fluid Catalytic Cracking Pilot Plant.

In designing the latest U.O.P. pilot plant, engineers had at hand extensive data which had been obtained through long study of catalyst circulation in glass models and operation of previous fluid-catalyst pilot plants, as well as the practical experience gained in the design and operation during the war of more than a dozen conventional type commercial fluid catalytic cracking units.

Certain of the features now embodied in the new pilot plant are illustrated in a small glass working

model in which the catalyst is circulated by compressed air. This model has been on display for months in the company's offices and has attracted considerable interest when shown at several meetings of refiners' associations.

The new pilot plant normally runs 3-4 barrels of fresh feed and recycle per day. Its principal parts are:

An electrically fired radiant tubular heater, really a miniature U.O.P. Equiflux heater.

A reactor-regenerator assembly approximately 23 feet high and 10 inches inside diameter, in which the reactor is at the top of the column and the regenerator is at the bottom.

A synthetic-crude condenser which cools and condenses the effluent from the reactor.

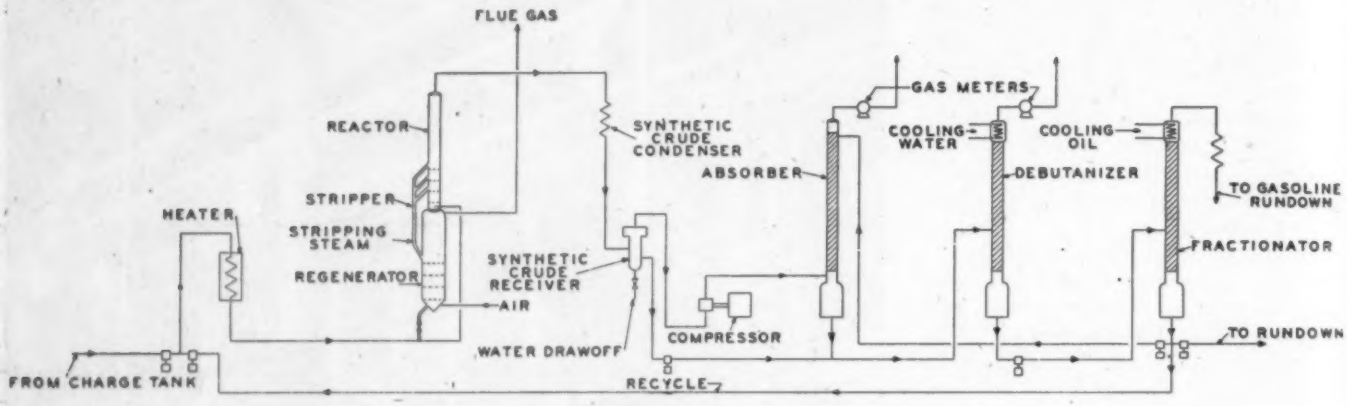
A synthetic-crude receiver provided to separate uncondensed gases from the liquid.

A compressor which takes uncondensed gases from the receiver and passes them to a high-pressure absorber for recovery of butane-butylene fractions which otherwise would be lost.

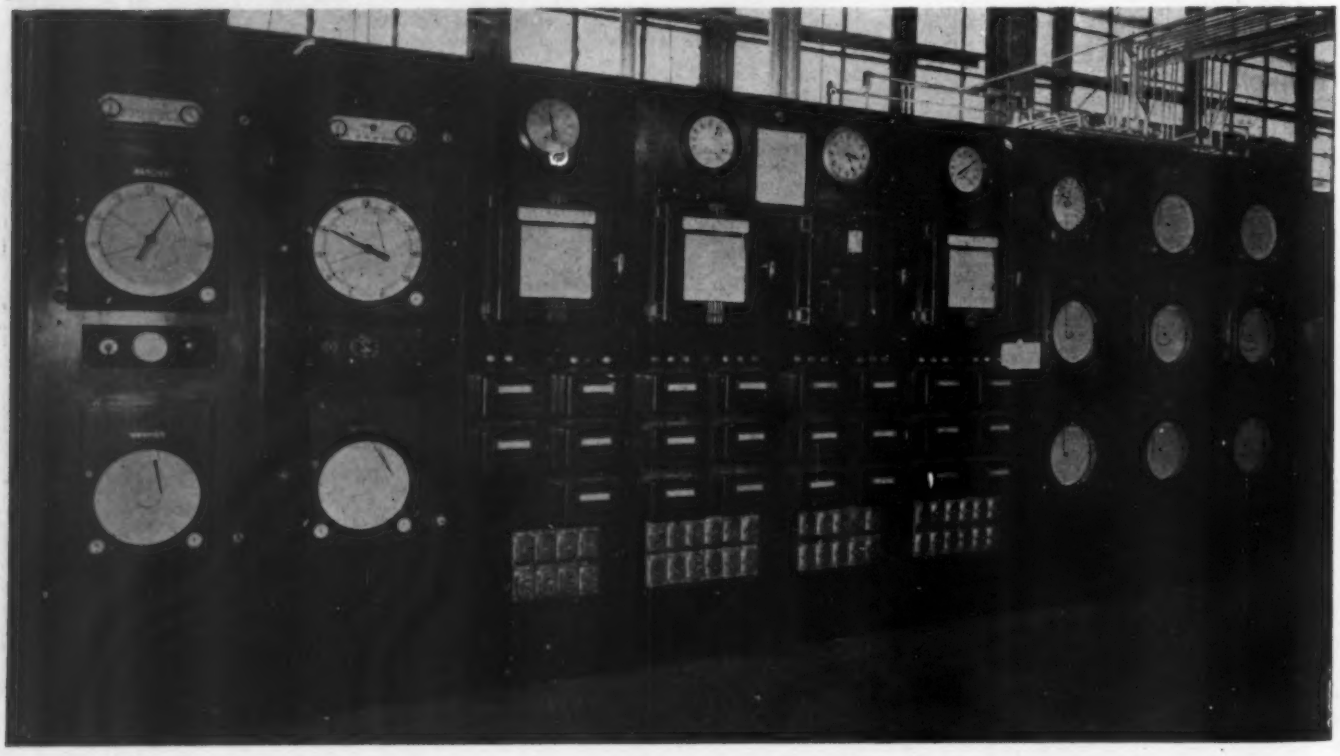
A debutanizer for removing the dissolved gas from both the synthetic crude and the rich absorption oil.

A fractionator which processes the debutanizer bottoms stream for separation of catalytic gasoline from unconverted gasoil. A portion of the gasoil is used as absorption oil in the absorber. The rest is recycled or removed as a net product.

Control instruments required for precise operation of the unit are mounted on an instrument panel which is necessarily at least as complete as that of a large commercial unit because of the variety of experimental data required.



FLOW DIAGRAM OF NEW U.O.P. FLUID CATALYTIC CRACKING PILOT PLANT



Instrument panel.

This new plant has been operated on normal gasoils, and also on heavy gasoils with endpoints up to 1000° F., and has confirmed the increased gasoline yield and reduced coke expected by the design engineers. The same features which produced these results in the pilot plant are incorporated in Universal designs for projected commercial units.

The accompanying diagram shows the flow through the pilot plant.

Chemical Constitution and Aromatic Groups In Petroleum Lubricants

Part 1

C. ZERBE and K. FALKENS

Translated by E. J. Barth, Petroleum Technologist from Brennst. Chem. Vol. 16, No. 9 (P. 161, etc.)

IN REFINING lubricants to enhance their stability and lubrication properties, chemical groups such as unsaturated compounds, resins and asphalt-formers are removed quite completely. However, there is another group which undergoes more or less complete removal—this group comprising the aromatics. When the refining or treating is with very strong sulphuric acid the aromatic groups are found in worthless form in the waste acid, and the acid sludge itself also is lost. When employing liquid sulphur dioxide in lubricant-extraction processes it is possible to selectively extract the various objectionable hydrocarbon groups, especially the aromatics, and obtain them in unaltered form after proper separation. Such extracted groups are then obtained in technically valuable form suitable for uses in other industries.

The solvent-extraction procedure developed by Edeleanu[1] is based on the observation that branched- and straight-chain paraffinic hydrocarbons are practically insoluble in liquid sulphur dioxide below a temperature of —10° C., the naphthene hydrocarbons being difficultly soluble at this temperature. Aromatic and unsaturated groups, on the contrary, are completely soluble in all proportions; however, a quantitative separation of low-carbon-content from high-carbon-content hydrocarbons is not possible commercially since the soluble aromatics exert a definite solubilizing effect on the otherwise insoluble naphthenes and paraffines.

The range of these secondary solution effects becomes wider and appears to increase with rise in temperature so that the working temperature for the extraction procedure must be still lower whenever these "solubilizers" are present in large quantities in a crude distillate. Commercially, a low temperature limit is set at which the process operates efficiently. The partition of aromatics between the two layers does not follow the partition law due to the fact that we are dealing with layers of oils and solvents which are slightly miscible. Technically, the partition law is made to work quite well, however, by using many small portions of solvent in succession on the same oil, extracting consecutively rather than using a large amount of solvent at once or in one extraction. The result is a continuous process as used today.

In order to gain some idea of the chemical character of the SO_2-soluble hydrocarbon portions present in lubricating oils we proceeded to extract an American asphalt-base spindle oil and studied the SO_2-soluble extract. The extract will be called E-extract. A comparison is also made of the refined oil or raffinate thus obtained comparing its properties with those of the extract. The refined oil is designated spindle-raffinate.

As will be seen below, the E-extract according to the constants we have obtained is classed as a typical aromatic material containing small amounts of unstable foreign substances. This was expected when one considers the solvent and its excellent solvent power for aromatics. That the aromatics prevail to a high degree in this extract can also be seen from data on the spontaneous-combustion properties of the raw oil and aliphatics.

In contrast to the curves obtained for the original oil and the final treated, which is distinctly aliphatic, the E-extract gives curves which are only shown by the aromatic hydrocarbons.[2] See Figure 1.

As mentioned already, the E-extract contains all the substances which would dissolve and react with sulphuric acid in an acid treatment. It is, therefore, not possible by treatment with 96 percent acid to affect a further separation, since even in the cold (at —3° C.) the acid reacts energetically, especially with the high-boiling-point portions of the extract. In contrast to this, the spindle raffinate is absolutely unreactive in two consecutive treatments with strong sulphuric acid.

When the E-extract fraction dissolved in light naphtha is treated at —10° C. with strong nitric acid (low temperatures are necessary in order to avoid drastic and deep-seated changes in the oil) one obtains light yellow-colored solid nitro products. A separation of the mixture by crystallization is not possible. Small portions drop out as brown oily resins and these are no doubt derived from ploymers of olefins, the olefins originally present with the aromatics in the raw oil.

Attempts to dehydrogenate the E-extract either with sulphur or selenium gave no results whatever, so that we can assume the absence of hydrogenated hydrocarbons in appreciable amounts.

We subjected next the E-extract to a careful high-vacuum distillation (with efficient column), and obtained cuts up to 70 percent off, boiling within 5° C. We noted a regularity in the increase of molecular weight, specific gravity, refractive index, and in the ratios of ultimate analyses values, with rise in boiling point. This indicates that an enrichment of concentration of individual hydrocarbons in all the cuts has been obtained. (See Table 1.)

In this connection we will now consider next the following facts: the viscosity characteristics of viscous aromatic tar oils is due to the solution of often solid resinous aromatics in high viscosity and resinous oils. When such oils are fractionated usually solid overhead distillates are obtained.[3] In contra-

distinction to this, the aromatics present in mineral oils, which are soluble in liquid SO_2 are normally viscous oils in all fractions. Typical fractions were selected out of the total distillate, showing their boiling-point ranges and other constants. (Table 1.)

By comparing the boiling point and specific gravity of these cuts of benzole derivatives of similar constants we form a picture of the type of ring compounds which are present:

TABLE 1

Analytical Constants of High-Vacuum Fractions of Extracts

B. P. Range	Mol. Weight	Specific Gravity	Ref. Index	Percent H	Percent C	Percent Rest	Formula	Series
261—280 °C	203	0.940	1.5326	9.85	82.1	8.0	C_4H_{19}	C_nH_{2n-9}
291—299	227	0.954	1.5392	9.8	84.8	5.4	$C_{16}H_{20}$	C_nH_{2n-12}
310—319	240	0.970	1.5499	9.74	85.9	4.3	$C_{17}H_{21}$	C_nH_{2n-13}
327—333	256	0.980	1.5596	9.68	86.3	4.3	$C_{18}H_{22}$	C_nH_{2n-14}
340—349	268	1.00	1.5721	9.24	85.6	5.1	$C_{19}H_{23}$	C_nH_{2n-15}
350—367	285	1.09	1.5803	9.19	84.3	6.5	$C_{20}H_{24}$	C_nH_{2n-16}
363—372	294	1.017	1.5855	9.09	85.8	4.1	$C_{21}H_{25}$	C_nH_{2n-17}
383—396	304	1.030	1.5917	9.00	85.7	5.3	.....	.....
	306	.....	1.6923	8.80	85.8	5.4	.....	.....

The aromatics present in the fraction 260-300° C. of the E-extract show a specific gravity of 0.94-0.96 and a refractive index of 1.53-1.54. The upper boiling-point limits of benzole hydrocarbons are lighter (0.90 specific gravity and index of 1.50) in contrast to the polycyclic aromatics whose specific gravity lies between 0.98 and 1.01. The fraction is therefore characterized as a mixture of mono- or bi-cyclic aromatics, or a mixture of bicyclic aromatics with many paraffinic or unsaturated side chains.

In the case of 300-350° C. and the 350-400° C. fractions the gravity and refractive index indicate benzole hydrocarbons in the bi- and polycyclic ring system. This is also indicated by the formulae derived from the ultimate analyses.

Liquid SO_2 also extracts, besides certain hydrocarbon groups, sulphur compounds present in the mineral oil. The removal is almost complete. Table 2 shows that the sulphur content increases with increase in boiling-point, the sulphur content of the raw extract being in this case 4 percent.

TABLE 2

Sulphur Content of Single E-Extract Fractions

Fraction	Percent Sulphur	Fraction	Percent Sulphur
1	2.1	6	3.5
2	2.1	7	3.6
3	2.2	8	3.5
4	2.3	9	3.5
5	2.5	Residue	4.1

Absorption Spectra of the E-extract

We next carried out spectrum analyses on fraction obtained between the initial and final boiling point, making absorption measurements in the ultraviolet region. The purpose in general was to elucidate how far it would be possible to really picture the chemical structure of petroleum oils, which most commonly is done by determining a set of physico-chemical constants.

Absorption measurements are based on generalization known as Lambert-Beer's law:

$$J = J_o \times 10^{-KCD} \qquad (1)$$

Where J_o is the intensity of the entering light ray, J, the intensity of the emerging ray (in the same direction) $J_o - J$ being the absorbed light, c the concentration in mols per liter, and d the thickness of the absorbing in centimeters; k is the molar absorption coefficient—a constant which varies in odd frequencies and is characteristic for every substance. In the equation log K is a function of the frequency (reciprocal centimeters).

The application of absorption measurements for determining the probable structure of oils is based on the following. The extinction:

$$K = kc = \log \frac{J_o}{\frac{J}{d}} \qquad (2)$$

is proportional to the concentration of the absorbing

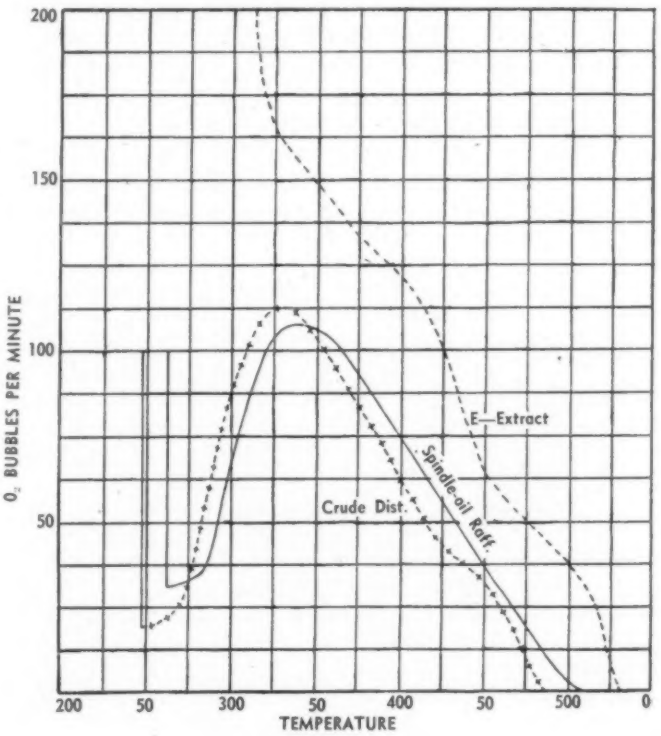


FIGURE 1

Spontaneous ignition curves

substance, and is an additive value, in the case of mixtures, of all the individual extinctions of the components in the mixture. What is especially characteristic for every substance is the height (K) and the position (ν) of the absorption-maxima. In the case of aromatics the position of the maxima of the first ultraviolet absorption-bands is displaced with increase in the substitution by aliphatic chains or similar substituents by small increments (800-2000 cm^{-1}) displaced or changed into longer wave lengths. During this condition the absorption intensity increases regularly. The displacement of the red is markedly stronger and the increase of the absorption is greater with increase in the number of conjugated rings. Figure 2 illustrates this. However, it is possible to "read off" a mixture from the large crested area of the extinction and thus to determine the maximum concentration of the component containing the conjugated rings. It will then become possible to identify

individual aromatic rings when the characteristic form of the curve for a ring is clearly seen in the neighborhood of the absorption maxima in any complete absorption curve of the mixture. In this case the concentration of the material in question can be determined from log K of the absorption maximum from equation (2). The limits of error of the absorption curves are of the order of about 0.02 in log K. The errors in the determinations for concentrations vary since they are dependent on the appearance of single maxima—that is, of the constitution of the mixture.

The absorption spectra of all oils tested lie definitely in the region of the longer ultraviolet wave lengths. Aromatic type compounds with more than one ring appear to be present from the results thus obtained. The results also are substantiated by additional analytical methods which one may apply as analytical tools.

From the measurements made thus far it is not possible to determine whether compounds exist and in what quantities, which might give spectra in the range of shorter wave lengths, such as benzole homologues, unsaturated oliphatics, and naphthenes. The

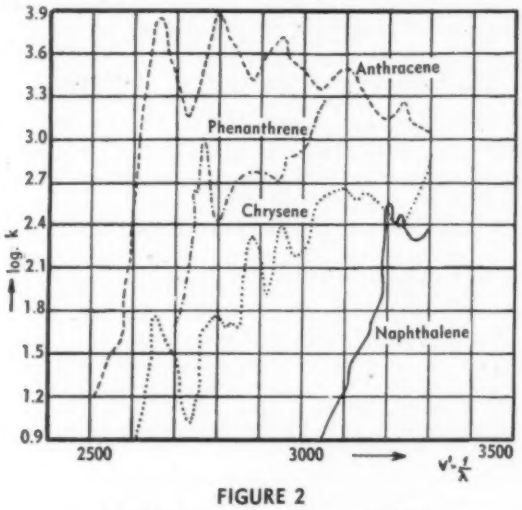


FIGURE 2
Absorption curves of pure aromatics.

absorption bands here are not visible due to being covered and hidden.

When one compares the results of the determinations of the oils tested (see Figures 3, 4 and 5) with absorption curves given by pure naphthalene, anthracene, phenanthrene, etc., under the same working conditions, we may state the following:

Fractions 1 and 2. The absorption curve of fraction 1 lies somewhat more in the range of longer wave lengths and is somewhat lower than that of pure naphthalene. The introduction of side chains in aromatic ring systems displaces absorption bands in the range of longer wave lengths. The presence of naphthalene type compounds is therefore indicated in a quantity calculated to be below 70 percent (determined from the height of the curve). Comparing further the absorption curve for fraction 2, we are led to the same conclusions; a still greater substitution of the double ring appears to exist in fraction 2.

Fractions 3 and 4. The curve for fraction 3 shows first of all the presence of still greater substituted compounds of the naphthalene type. The same, however, cannot be said for fraction 4, where such compounds do not seem to be present. The first maximum and minimum of the curve resembles very much that of phenanthrene. We may therefore take it that phenanthrene type of compounds is present.

Fractions 5 and 6. Here the quantity of phenanthrene type compounds increases further and reach a maximum as to quantity in No. 6 cut. The displacements in the long-wave-length region and the height of the curves show definite and pronounced substitution. According to the curve heights shown, approximately

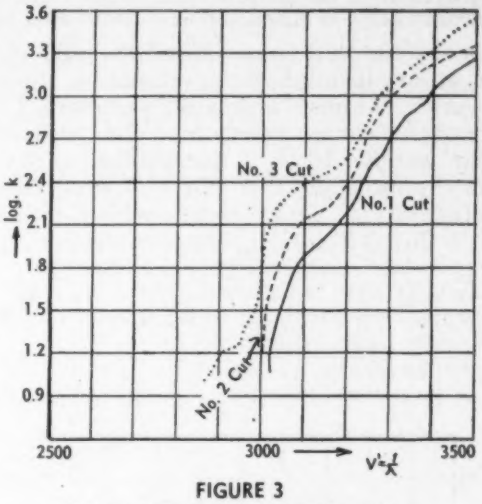


FIGURE 3
Absorption curves of Fractions 1-3.

90 percent of such derivatives are present. (Comparison was made with cp. phenanthrene.)

Fractions 7, 8 and 9. According to the absorption determinations there would appear to be present hydrocarbons probably containing even a greater number of rings than does phenanthrene. Summariz-

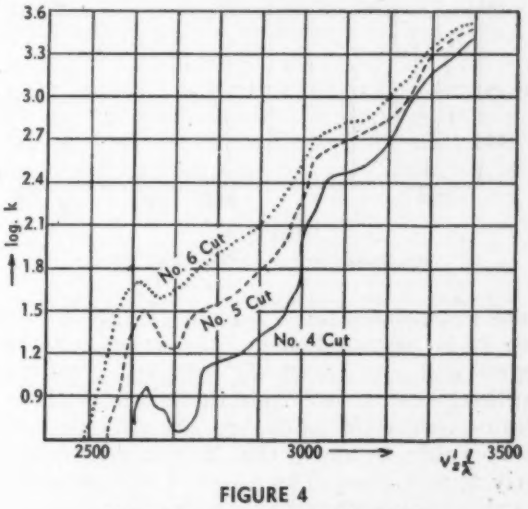


FIGURE 4
Absorption curves for Fractions 4-6.

ing the results so far we have tabulated the absorption determinations on all fractions as follows:

TABLE 3
Constitution of Fractions 1-9

Fraction 1 & 2	260-300C.	A naphthalene derive. (60-80%); also probably a benzole deriv.
Fraction 3 & 4	300-350C.	Increasing amounts of phenanthrene; large amounts of deriv. of naphthalene (80%).
Fraction 5 & 6	350-370C.	Few naphthalene deriv. more phenanthrene deriv.
Fraction 7, 8 & 9	370-400C.	Considerable phenanthrene and polyaromatics.

Starting out with the aromatic types we have so far discussed and which we decided were present from absorption measurements, then the analytically determined value for the number of hydrogen atoms

allows further insight into the nature of these groups—namely, to what extent or how the total carbon content is distributed between aromatic and aliphatic structures.

1. One atom of hydrogen in long chains, in hydrogenated rings and side chains corresponds to..½ aliphatic C atom.
2. A hydrogen atom in benzole.....1 arom. C atom.
3. A hydrogen atom in naphthalene.....10/8 arom. C atom.
4. A hydrogen atom in phenanthrene...14/10 arom. C atom.

Let us assume that in an unknown molecule there are x C atoms in aliphatic combination, then there are (C—x) C atoms "aromatic," wherein C is the number of C atoms determined by analyses and molecular weight. If H is the number of hydrogen atoms in the molecule then the following relation is true, referring to naphthalene, which is basically present in No. 1-3 cuts, as determined by spectrum analyses:

1. $2x + (C - x) \times 0.8 = H$, or $6x = 5H - 4C$.

The expression will have to be altered for the presence of other basic groups.

For phenanthrene, therefore, we have:

2. $2x + (C - x) \cdot 10/14 = H$, or $9x = 7H - 5C$.

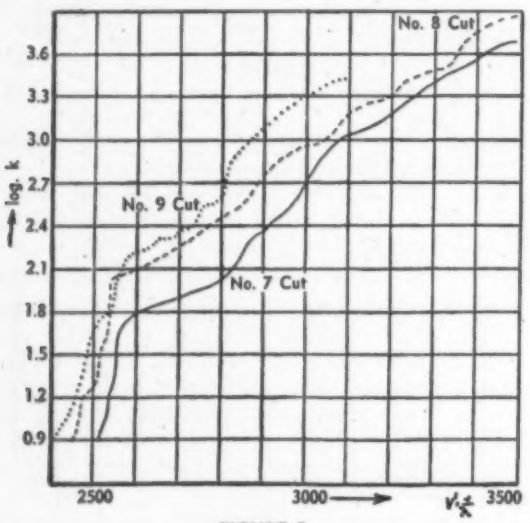


FIGURE 5
Absorption curves for Fractions 7-9.

In the case of fractions 4-7 we employed equation 2 since it is assumed that the ratio of carbon to hydrogen will not be vastly different from that of phenanthrene due to any unknown combinations. The calculations thus obtained are shown in columns 4 and 5 in Table 4, where the carbon percentages are properly apportioned. The proof of the correctness of these calculations must rest on the agreement of the observed molecular refraction (R I) and the calculated refraction (R II). To calculate molecular refraction (R I) we employed the formula:

$$\frac{(n^2 - 1) \times m}{(n^2 + 1) \times d} = RI.$$

The determined values for refractive index (n), molecular weight (m) and density (d) are inserted in the formula.

The molecular refraction R II is additively obtained from the product of refraction equivalents and the number of given atoms in the compound. From this we obtain the corresponding values:

Hydrogen	1.10
Carbon ("aliphatic")	2.24
Carbon ("aromatic") for naphthalene	3.56
Carbon ("aromatic") for phenanthrene	3.80

Besides carbon and hydrogen the oils are also made up of hydrocarbons containing various amounts of nitrogen, oxygen and sulphur. Since these organic groups show about the same refraction equivalents (based on equal weights, not on the number of atoms) as an aliphatic carbon atom, one can insert an index of 2.24 per 12 grm. for this group. As shown in Table 4, R I and R II agree well within an experimental error of +3 percent. Now there is a general experimental error of +3 percent inherent in the determination of molecular weight, as also for the calculation of molecular refraction. A maximum deviation of 6 percent (the average is 3 percent) is therefore to be accepted. The fact that the agreement between R I and R II lies well within this range of experimental error substantiates the correctness of our calculations derived and based on the absorption curves and analyses.

The indicated limit of error of 3 percent allows some small variations in arriving at the constitution of simple fractions. For instance, a part of the aromatic carbon could be replaced by a corresponding number of double bonds (unsaturated aliphatics), or the ring could be replaced in part by some similar group, without having the calculated refraction fall materially outside the limit of error when comparison is made with the observed value.

Thermal Decomposition of E-Extract

If the conclusions drawn from absorption spectra and from the indicated calculations are correct then one would be able to obtain by thermal decomposition hydrocarbons whose absorption spectra would be fairly similar in type to those indicated above.

We conducted the cracking in a galvanized iron tube, in the presence of hydrogen in order to prevent deep-seated cracking. This procedure was first used by F. Fischer and Schrader[4] who showed it was thus possible to de-alkylate aromatics and still preserve the ring. Also an accumulation of aromatics from aliphatic unsaturated residues is held to a minimum as far as we could observe.

During the thermal split-up of individual fractions one obtains a black tarry oil, which is the reaction product. Solid products usually settle out of this product after long standing. Uncondensed gases, fog or heavy vapors were not observed; such appearance of vapors, usually non-condensable, indicate cracking. The reaction product comprised about 50 percent of the original stock.

Table 5 shows the physico-chemical constants of the cuts obtained by vacuum distillation of the reaction product. The quantities indicated for the first fraction are in reality higher, since we could not eliminate losses of low-boiling-point benzole-type hydrocarbons, during high-vacuum distillation.

The distillation residue from every fraction consisted of a hard resin-like material—not very soluble

TABLE 4
Distribution of Carbon Content in Fractions 1-8.

No.	H Atoms	C Atoms	C Arom.	C Aliph.	Ratio C Aliph. To C Arom.	R I	R II
1	19.9	13.9	6.5	7.4	1: 1.14	66.6	66.5
2	21.5	16.0	8.1	7.9	1: 0.97	75.0	74.3
3	23.2	17.2	9.3	7.9	1: 0.85	78.8	79.9
4	24.6	18.4	10.1	8.3	1: 0.82	84.5	85.2
5	24.5	19.2	10.8	8.4	1: 0.78	88.0	90.9
6	26.0	20.0	10.9	9.1	1: 0.81	94.4	94.8
7	26.5	20.8	11.8	9.0	1: 0.76	97.3	97.1
8	27.2	21.7	12.7	9.0	1: 0.71	100.1	101.8

in benzole. As one would expect, the cracked tar from the E-extract comprises a mixture of compounds similarly found in the aromatic coal-tar residues. Edeleanu[5] had also observed materials of this type from the cracking of an SO_2-extract derived from kerosine. Comparing the results of cracking

Viscosity Measurements

Removal of aromatics from any mineral oil in general greatly improves the temperature-viscosity relationship of the oil. In the case of the paraffinic oils viscosity decrease is at a minimum with rise in temperature, while the aromatics show sharp loss in

TABLE 5
Composition of Cracked Products

B. P. Range	Condition	Percent	d_{15}	n_{D15}	Main Constituents:
FRACTION 1:					
75— 87 C	Fluid	3.0	0.9402	1.522	Benzole hydroc.
87—105	Solid	6.5	....	....	100 percent naphthalene
105—130	Fluid	37.0	1.027	1.615	Mix higher aromatics
170—240	Solid	10.0	....	....	Anthracene
FRACTION 2:					
80— 90 C	Fluid	1.5	....	....	Benzole hydroc.
90—105	Solid	20.0	....	....	Same as No. 1 Fraction above
105—145	Fluid	12.0	1.0363	1.615	Same as No. 1 Fraction above.
145—200	Solid	7.0	....	....	Same as No. 1 Fraction above.
FRACTION 3:					
80— 85 C	Fluid	1.5	....	1.552	Same as in Fraction No. 1
95—140	Solid	7.5	....	....	Same as in Fraction No. 1
140—190	Fluid	6.0	1.0804	1.616	Same as in Fraction No. 1
190—215	Solid	7.5	....	....	Same as in Fraction No. 1
FRACTION 4:					
90—135 C	Fluid	6.0	0.9111	1.528	Same as No. 1 Fraction
135—160	Solid	6.7	....	....	Same as No. 1 Fraction
160—200	Fluid	7.2	1.0515	1.619	Same as No. 1 Fraction
200—235	Solid	27.5	....	....	Some phenanthrene also
FRACTION 5:					
88—110 C	Fluid	1.5	0.9247	1.541	Same as No. 1 Fraction
110—125	Solid	12.0	....	....	Same as No. 1 Fraction
125—170	Fluid	15.0	1.0831	1.643	Same as No. 1 Fraction
170—255	Solid	24.5	....	....	40 percent anthracene + 60 percent phenanthrene
FRACTION 7:					
60— 90 C	Fluid	1.5	....	....	Same as No. 5 cut
90—105	Solid	9.0	....	....	Same as No. 5 cut
105—150	Fluid	9.0	....	....	Same as No. 5 cut
150—185	Solid	30.0	....	....	Same as No. 5 cut
220—250	Solid	13.0	....	....	Chrysene
FRACTION 9:					
60— 90 C	Fluid	1.5	....	....	Same as No. 5 cut
90—105	Solid	7.0	....	....	Same as No. 5 cut
105—150	Fluid	8.0	....	....	Same as No. 5 cut
150—185	Solid	22.0	....	....	Same as No. 5 cut
205—220	Solid	34.0	....	....	Anthracene, phenanthrene, & Chrysene

with our tentative conclusions drawn from the absorption data so far obtained, it can be said that the conclusions from both sets of observations are quite well in agreement for all the fractions. We have

viscosity as temperature increases. This is shown graphically in Figure 6 in the curves for the three original stocks. Comparing the viscosity-curves of similarly boiling-point portions of both components

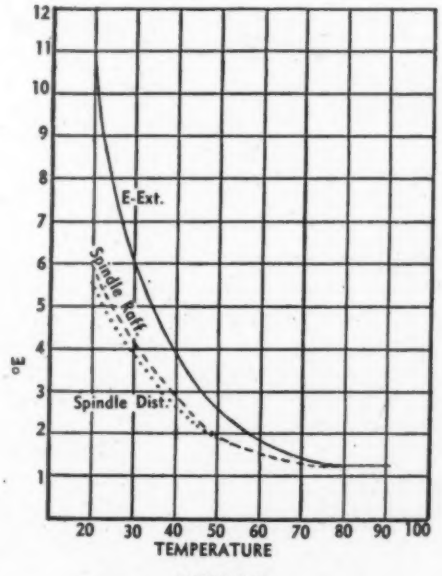


FIGURE 6
Viscosity curves (raw stocks).

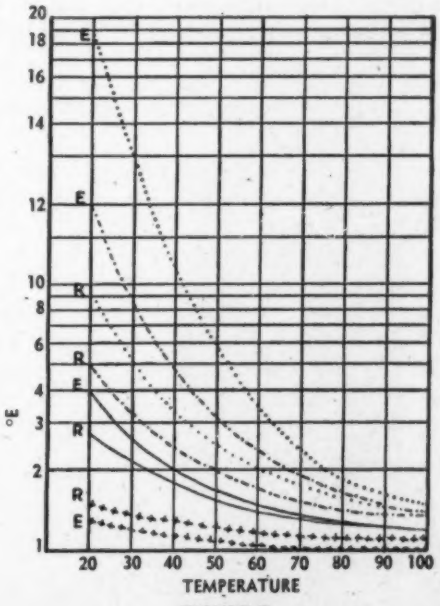


FIGURE 7
Comparison of similar boiling points—spindle raffinate and E = extract fractions.

determined the nature and also to some extent the quantity of several basic hydrocarbon groups present in these extracts, by the described procedure of spectrum analysis.

(Figure 7) it is seen that in single boiling-point ranges the viscosity of aromatics is about 20° higher than similar boiling-point aliphatics; at higher tem-

peratures viscosities of both series approach each other and are practically identical at 100° C.

Considered therefore also from the angle of viscosity, the SO_2-soluble aromatics present in mineral oils appear to behave similarly to the aromatic coal-tar oils[6]; and viscous synthetic lubricants made by hydrogenation of aromatic oils fall into the same category.

We will discuss in a later contribution how much improvement in viscosity index can be obtained by adding on hydrogen to the oil molecule.

Description of Tests

The raw stock which we worked with was American spindle oil. The quantity of E-extract ranged between 20-30 percent. See table below:

Table of Results

ANALYSIS	Spindle Dist.	E-Raff.	E-Extract
d_{20}	0.916	0.880	1.002
Flash, Open (°F)	158	158	155
Viscosity 50C (E. deg.)	6.1	5.6	2.4
Pour Test	Below —40	Below —40	—30
Neut'n No.	3.8	3.0	5.2
200 gm. Vac.-Dist. of E-Extract			
At: 12mm	To 150 °C To 200 °C	5% 36.5%	d_{20} 0.98 d_{20} 0.99
At: 5mm	To 200 °C To 230 °C Redisue	28.5% 20.0% 10.0%	d_{20} 1.0 d_{20} 1.01 .....

High Vacuum Distillation. Forty-two kilos of water-free E-extract were distilled in an iron still (without column) under high vacuum, using 6-kilo charges each time. Nine large fractions were obtained. Fifteen percent of still residue were discarded each time in order to separate asphalt and resins. Fractions of similar boiling-point range were combined, and redistilled under high vacuum, using a column filled with Raschig rings (12 inches tall, 2 inches wide). Fractions of equal boiling-point range and specific gravity were again combined and again distilled under high vacuum, using a larger Raschig column, 24 inches tall, and 2 inches in diameter; nine fractions were obtained. These are shown in Table 1.

Boiling points were determined by Engler's method: small residues left in the flask, due to cracking in this particular test, we disregarded.

Viscosity Determinations. Viscosities were run in either an Engler apparatus or in the Ubbelohde capillary apparatus. Viscosity curves were constructed according to the method of Dallwitz-Wegner.

Absorption Measurements. We employed pure hexane; the determinations were made on a chemist's spectrograph (quartz-optic). The method employed the rotating sector principle. A copper-iron ray was the source of light. The measuring medium is fixed or placed in a logarithmically stepwise arranged cell according to Scheibe.

Summary

1. Liquid sulphur-dioxide-soluble constituents present in an American spindle oil were investigated; individual group constituents were separated by high vacuum-distillation procedures.

2. The molecular size of the groups including sulphur derivatives increases with increase in boiling point.

3. The chemical constitution of individual fractions was arrived at by absorption-spectrum analyses; aromatic and aliphatic combinations of hydrocarbons were calculated to be present. A good agreement was found between the observed and calculated molecular refraction.

4. The presence of the above-mentioned groups indicated by absorption spectra results was further substantiated by thermal cracking.

5. Temperature-viscosity curves of individual fractions were compared with those for spindle-raffinates.

BIBLIOGRAPHY

[1] Ger. Patent 216459; 546123.
[2] Zerbe & Eckert: Angew. Chem. 45, 593 (1932).
[3] Zerbe & Eckert: Brennst. Chem. 15, 28 (1934).
[4] F. Fischer & H. Schrader, Ges. Abhandl. Keunt. der Kohle 6, 128 (1922).
[5] Edeleanu: Angew. Chem. 36, 573 (1923).
[6] Zerbe & Eckert: Brennst. Chem. 15, 30 (1934).

End of Part 1—Part 2 will appear in an early issue.

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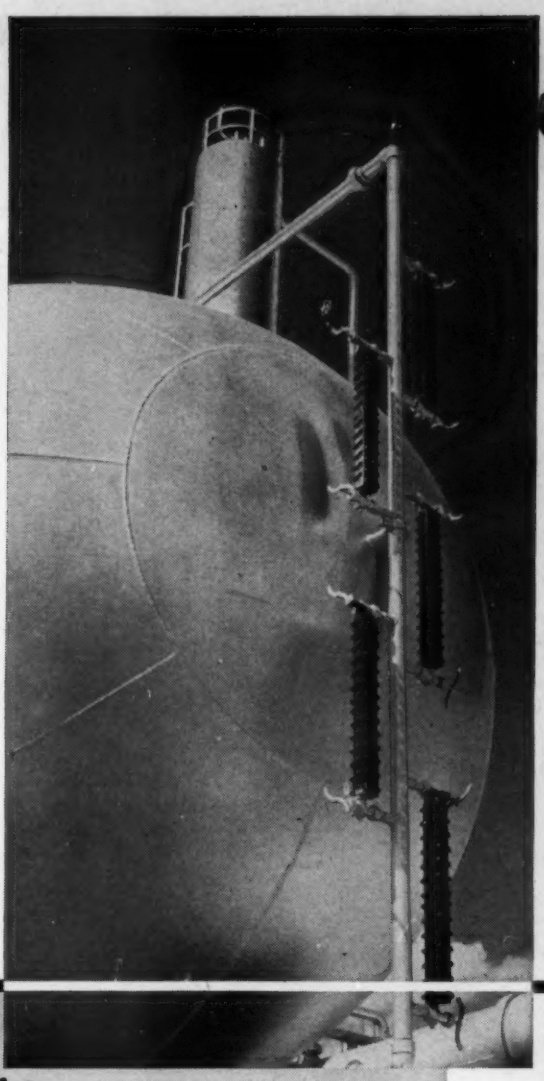
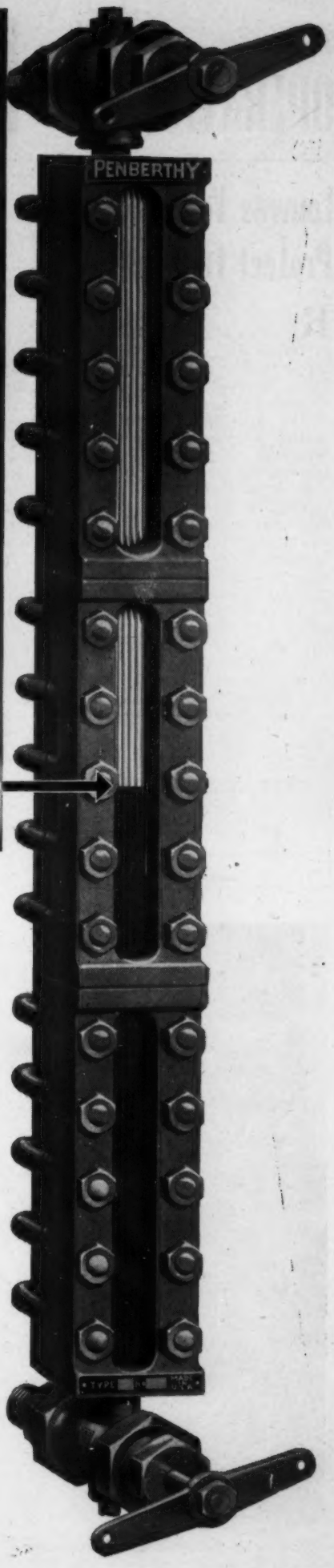
LIQUID LEVEL





Use

PENBERTHY "REFLEX" GAGES

DROP FORGED STEEL

There can be no error in reading the liquid level when you depend upon Penberthy "Reflex" Gages. The contrast between the black portion of the glass showing liquid and the white portion showing empty space is sharp and unmistakable.

Penberthy Drop Forged Steel Reflex Gages are available in whatever lengths required and for various liquids; they meet API—ASME requirements and are recommended for pressures up to 3000 psi at 100° F and 1000 psi at 1000° F.

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2286

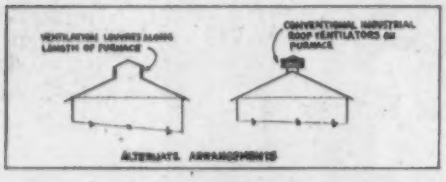
OPERATION HOW TO DO IT MAINTENANCE

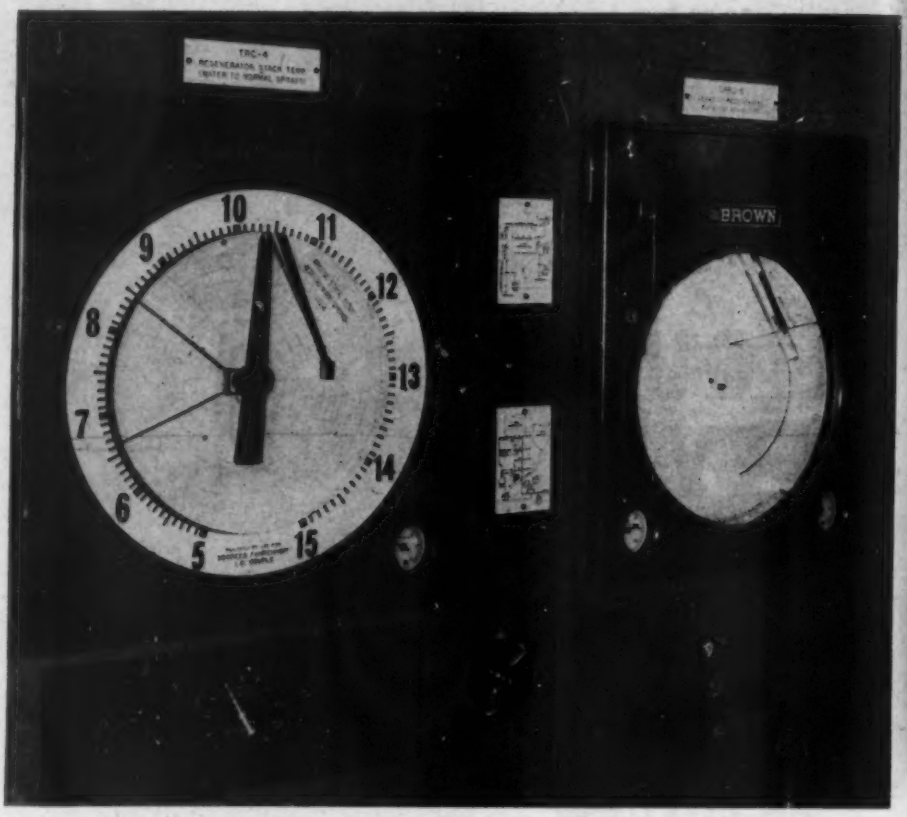
Louvres Ventilate and Protect Furnace

REFINERY oil heaters usually are designed with flat suspended refractory tile arches above the combustion chambers, various forms of metal tie rods or support castings carrying the weight of the individual tile pieces. Good ventilation of the metal support system is required, to prevent failures from excessive temperatures, but at the same time it is necessary to protect the hot refractory from damage by rain. Common practice utilizes a light-weight sheet metal or composition roof supported at some little distance above the furnace and open at the ends to allow free circulation of air. Wide overhanging eaves and gables are used to keep rain away from the refractory arch, but even so, high wind velocities may blow water into the furnace, and the whole structure is somewhat subject to wind damage because of the large projections.

Republic Oil Refining Company at its Texas City Refinery has met this problem with a novel design. The furnace roof is made just as wide as the furnace, and special sheet metal ventilating louvres are provided at the gable ends of the roof for ventilation, allowing free circulation of the atmosphere and giving satisfactory cooling of the tile arches, but keeping water out.

Alternative schemes not used at the Republic plant, but designed to accomplish the same results employ more or less conventional building type roof ventilators.


VENTILATION LOUVRES ALONG LENGTH OF FURNACE
CONVENTIONAL INDUSTRIAL ROOF VENTILATORS ON FURNACE
ALTERNATE ARRANGEMENTS



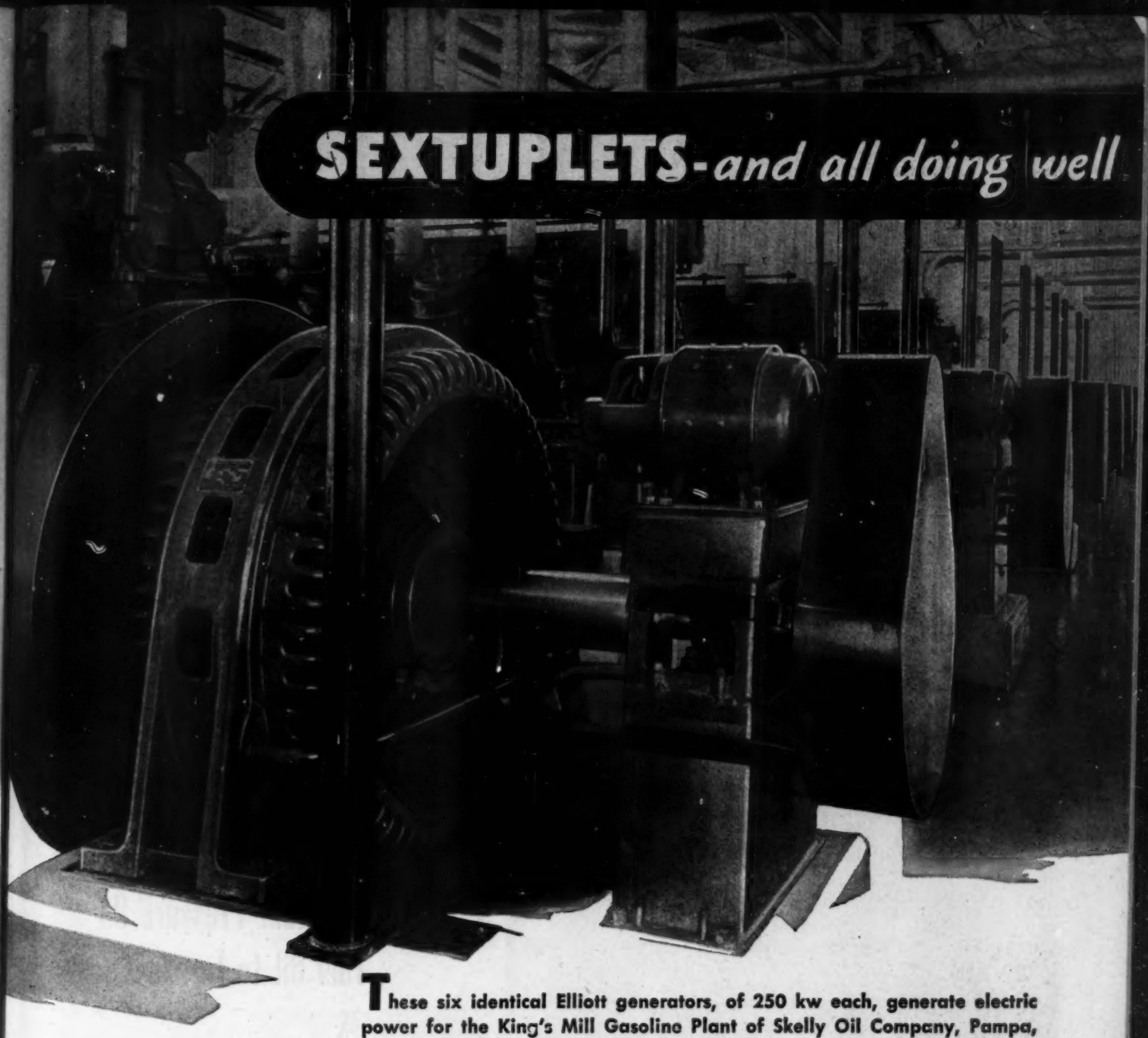
Small sections of the process control diagram are engraved on white plastic and mounted on the instrument panels to illustrate graphically the application of specific instruments and the location of control points and thermocouples in the new Shell Oil Company cracking unit at Houston).

Louvres in the furnace roof eaves provide necessary protection and permit free ventilation.

Revamping Corrects Wax Rundown Tank Hazard

Tanks shown in the accompanying photograph are improved 15 feet (diameter) by 20 feet (high) wax rundown vessels of the Magnolia Petroleum Company's Beaumont refinery solvent dewaxing unit. Formerly the tanks had gas-tight cone roofs vented through gooseneck connections and had flat steel bottoms. Water from various sources found entrance into the tanks, causing roof ruptures in two instances, and this presented a safety hazard from scattering

SEXTUPLETS-*and all doing well*



These six identical Elliott generators, of 250 kw each, generate electric power for the King's Mill Gasoline Plant of Skelly Oil Company, Pampa, Texas. They are driven by Ingersoll-Rand gas engines, and their power operates pump and fan motors and other auxiliaries, besides lighting the plant as well as the nearby employee housing camp. Four of them purr along pretty continuously, the others swelling the symphony of power when peak demands arrive.

This fine new power installation gives its owners fine new savings, realized in considerable measure by the unswerving dependability of the Elliott generators.

ELLIOTT COMPANY
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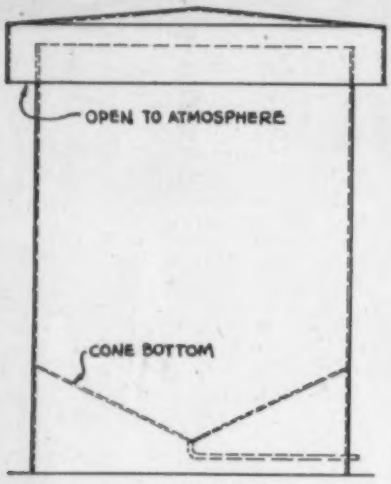
J-707

Elliott GENERATORS
DO WELL WITH ANY DRIVE

of hot wax over a relatively large area.

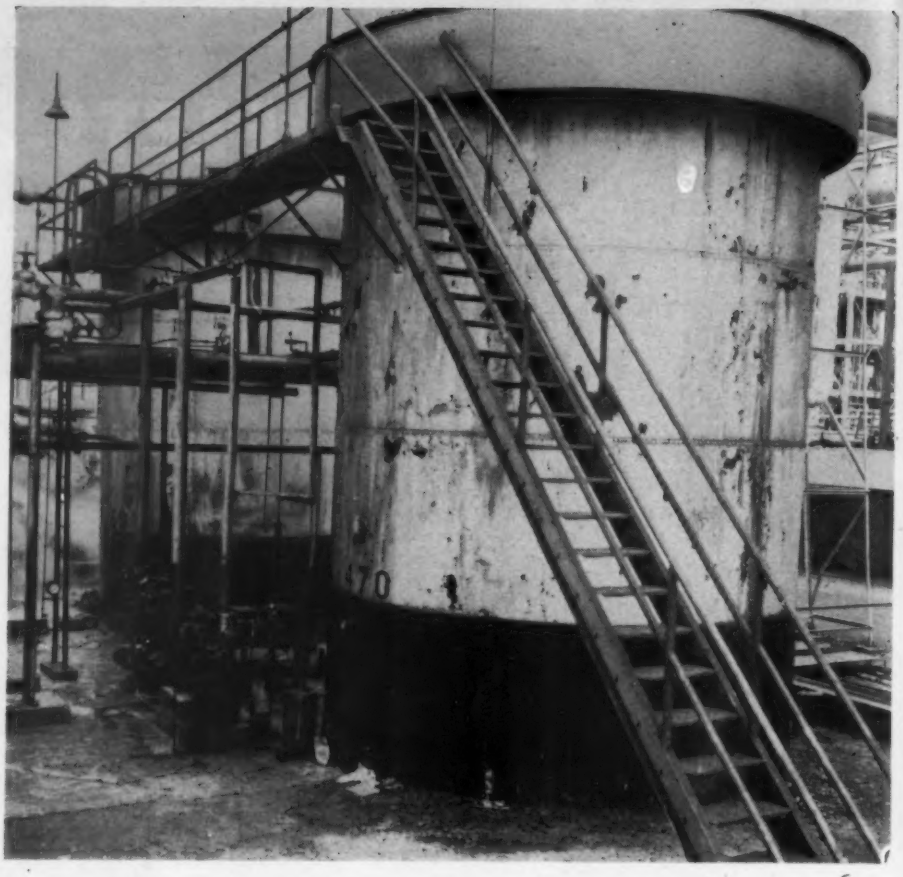
Each tank has an umbrella type steel roof containing a continuous opening of about eight inches between the tank roof and shell, and each vessel has been equipped with a cone bottom (approximate slope of two inches per foot). The



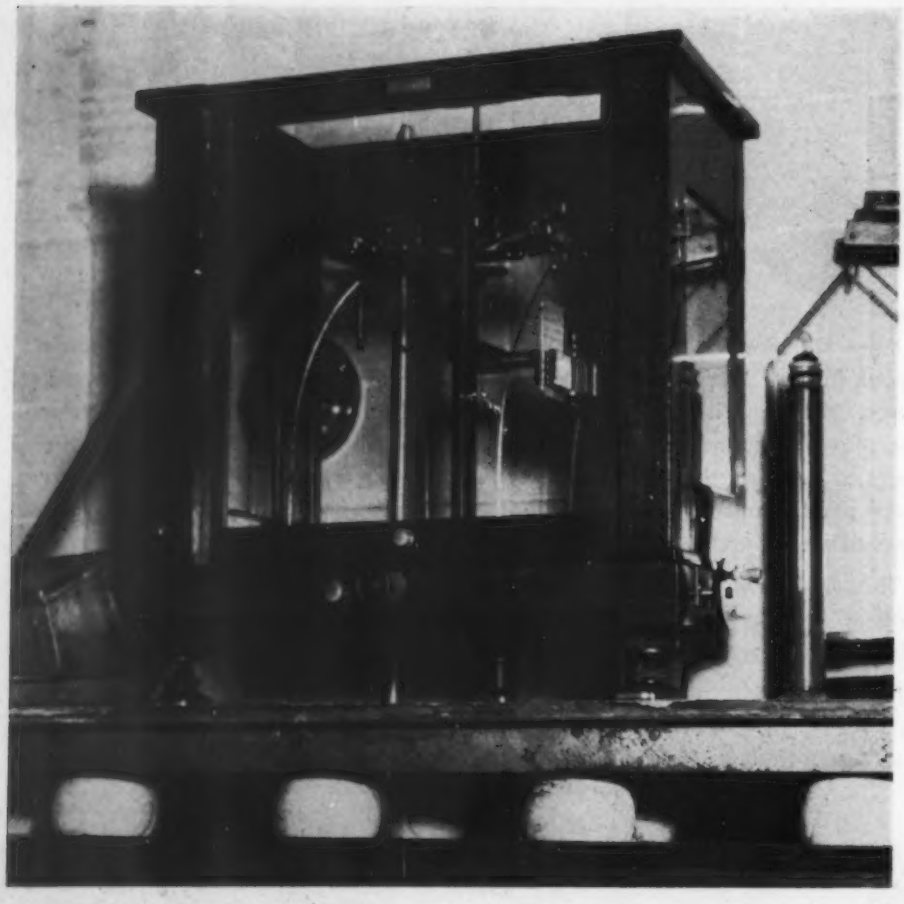
water draw connection is arranged with a gooseneck extending into the vertex of the cone.

The revamped tanks have been in operation for some time and have eliminated the hazard previously experienced.

—Submitted by C. M. Fabian, assistant superintendent, Magnolia Petroleum Company, Beaumont, Texas.



Umbrella roofs and cone bottoms for dewaxing unit run-down tanks at Magnolia Petroleum Company's Beaumont refinery corrected a safety hazard. The photograph shows roof construction, and sketch at left reveals interior construction.



TENNIS BALL VIBRATION DAMPENER

A sensitive balance in the control laboratory of the new Shell Oil Company catalytic cracking unit at Deer Park was exposed to vibration because of its location in a process area. This vibration was too slight to be noticeable to unit operators but was sufficient to interfere with accurate weighing. The balance was mounted on a heavy steel plate which is in turn supported by a number of tennis balls positioned above a wooden table, moldings around the table edges serving to anchor the assembly. By this means sufficient damping is obtained to allow accurate weighing of test items.

Constant Pressure On Fuel Oil to Furnaces

ALLEGANY Refiners, Inc., at Bolivar, New York, was confronted with a shut-off from industrial gas fuel made necessary by unprecedented domestic demand and because of depleted production in the service area. So that the refining plant would not be shut down, the management turned to liquid fuel for process heaters and boilers. After setting pumps to circulate the fuel and installing proper burner equipment, it was noticed that the short hesitation between strokes of the reciprocating fuel pumps was translated into flame pulsation. The problem might have been solved by installing centrifugal pumps working on a constant pressure head, but this type of equipment was not available at the time.

A solution was found when the plant engineers investigated pulsation dampeners. The dampeners made in the plant shops are vertical chambers of 10-inch pipe set as closely to the fluid end of the fuel pumps as practicable, and installed

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For the benefit of present and prospective Houdry licensees, whose operations are too small to support extensive technical staffs, Houdry offers a complete engineering service covering all phases of refinery and associated operations.

No other technical organization can illuminate the problems of modern refining with so extensive a background of catalytic research and commercial experience as the Houdry organization. Twenty-three years of scientific research and ten years of intimate association with commercial cat-cracking are the solid foundation of Houdry Service. Its framework is a distinguished staff of engineers, chemists and economists, reinforced by hundreds of analysts, operators, testers and mechanics in the great Houdry Laboratories.

For refiners interested in catalytic cracking, Houdry facilities are available for a complete refinery survey including process engineering studies, economic analyses and pilot-plant evaluations.

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HOUDRY CATALYTIC PROCESSES

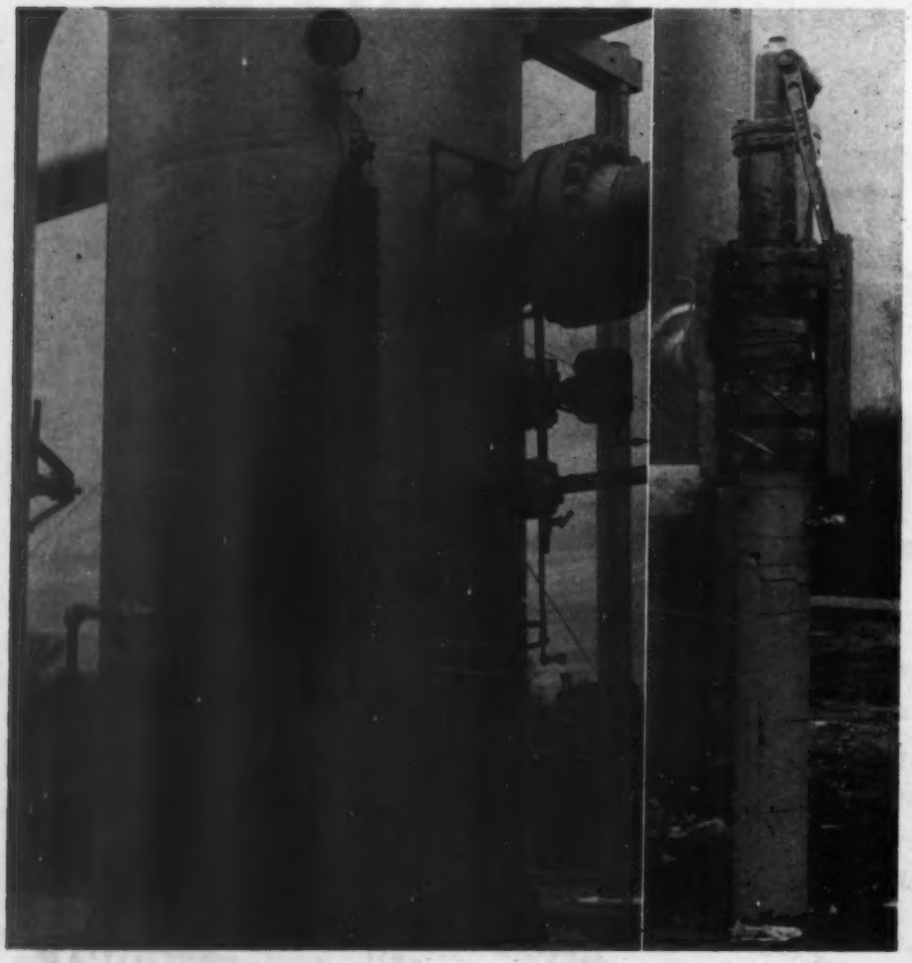
with connections near the base on each side for crossflow of fuel—in and out—a gauge glass on the side of the chamber indicates height of oil in the chambers while the pump is operating. A connection in the top head of the unit contains a truck-tube valve stem for filling the chamber with compressed air for control of fluid level in the chamber, which is maintained at approximately one third of the vertical distance.

In operation, the fuel pumps are started directing oil directly through the lower section of the dampeners through supply lines to the burning equipment, excess oil flowing back to the supply tank through return lines. The pressure maintained on the pump discharge is approximately 150 psig, and as soon as the flow has been established, the operator introduces compressed air into the chamber to lower the liquid level to the required height. Air is placed in the chamber with a filling station air hose, having an inflation head attached which fits the valve stem in the top head of the chamber. This arrangement was decided upon to prevent possible back-flow of fluid through check valves, and to prevent leaking of air from the source to the chamber.

The result of this experiment is reflected in a constant pressure on the fuel oil at the burner heads regardless of the hesitation between strokes of the fuel pumps.

CHEMICAL MIXING WORM

When crudes are chemically treated in conjunction with desalting operations it is desirable to have chemicals and crude thoroughly mixed before they enter the salt-settling drum. Republic Oil Refining Company in its plant at Texas City has provided good mixing of chemicals and crude in one of its units by installing a pipe-worm mixing device immediately ahead of the salt-settling drum. For convenience the worm was located on a special support rack above the drum.



Freezing of liquids in level gauges, pressure gauges, and a liquid-level-control instrument on a gasoline plant's separator was eliminated by using quarter-inch copper tubing coils heated by exhaust steam. The tubing was used as shown at left. Two turns of the tubing were made around the liquid-level gauge valves and the pressure-gauge valve. Vertical loops of the tubing are held to the face and back of the level gauges by wire. Similar treatment was accorded on high-pressure lines at other points in the plant, with the insulation applied as shown at right.

Valve Stem Protection On Buried Pipe Lines

MAINTENANCE of valves on lines buried near the ground surface can become costly and time-consuming if not properly installed. One company makes it a practice of protecting valves and valve stems located in lines buried at shallow depths. Illustrated is a typical example of such a method of protection. When the line is installed, a short nipple of 10- or 12-inch casing is fitted over the valve, the lower end of the nipple being slotted to fit around the pipe. This nipple is of sufficient length to extend

Valve Cover

Extraordinary Tube Cleaners

ROTO WATER JET

The most powerful and economical water-driven tube cleaner ever built

Gives you MORE THAN **100% increased power, and 80% less water consumption per hp than previous Roto equipment**

The new ROTO Water JET now makes it possible, for the first time, to remove the most stubborn scale quickly and effectively with a water-driven tube cleaner. No other water-driven tube cleaner motor ever built develops such great power, and so economically.

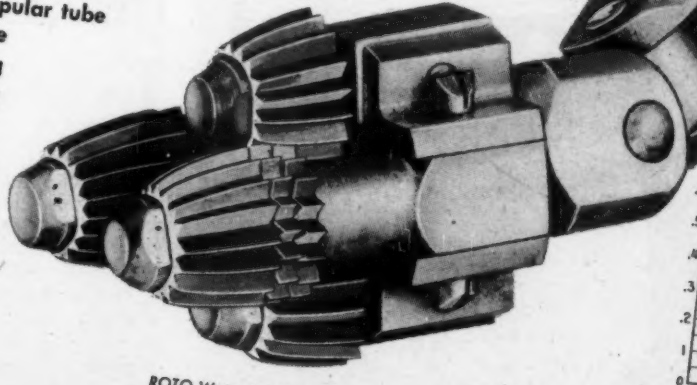
A radical design change in the turbine wheel and other parts, based upon recent developments in hydrodynamics, is responsible for superior performance of the new ROTO Water JET Motor. See the graph. For instance, the new ROTO Water JET Model 321 for 2¼" I.D. straight tubes develops 107% more power at 130 psi than the former Roto Model 21, and uses 80% less water per horsepower.

Some of the first ROTO Water JET Tube Cleaners were loaned to local plants for field tests. Not one of the users wanted to return them to us for examination without a promise that we would give them priority on the first regular shipments.

ROTO Water JET motors are now being made for the most popular tube sizes. Other sizes will be available shortly. Existing Roto heads and operating hose fit the new motors.

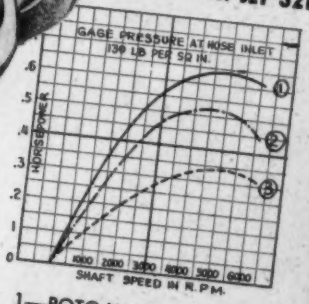
The time, labor, and water it saves will soon pay for your new ROTO Water JET Tube Cleaner, and you will get a much cleaner job than with any water-driven cleaner you ever had.

Send for details and prices.



ROTO Water JET Motor Model 321 with short 4-arm head and universal joint for 2¼" I.D straight tubes.

BRAKE HP vs SPEED ROTO Water JET 321



1—ROTO Water JET #321
2—Best competitive motor
3—Old Roto #121

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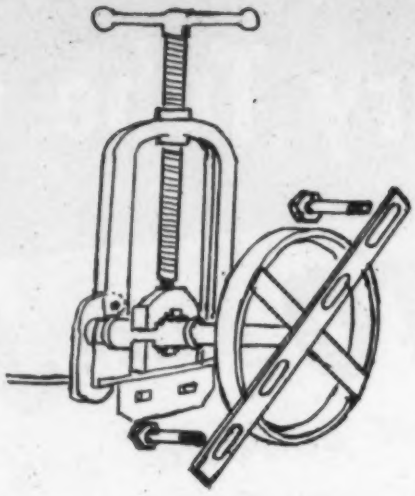
slightly beyond the top of the valve stem, thus affording it protection and assuring free operation of the valve stem which might otherwise be lodged with rocks or hardened ground.

A top is fitted on the nipple with a handle made from reinforcing rods. The lid fully covers the large nipple. Small lugs welded on the underside of the lid insure centering and keeps it in place.

Jig Aids Welding Fittings to Flanges

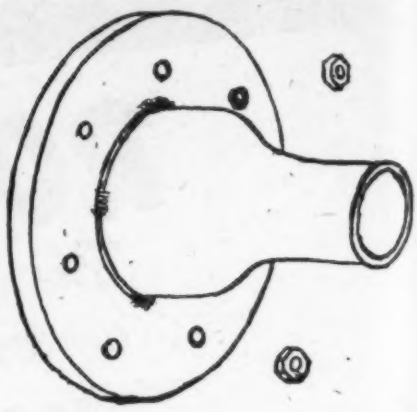
TO SPEED up and facilitate welding swedge nipples, factory-made tube turns, and short nipples to various-sized pipe flanges, one welder fabricated a simple jig for holding and rotating the fittings during the welding process.

The outer ring of the jib is formed by cutting a slice, 2 inches wide, from the end of a salvaged joint of 12-inch pipe. A 20-inch length of flat iron, 2 inches in width, is secured to the edge of the ring so that the center line of the strip divides the ring in half, and extends about 4 inches beyond the edges of the ring.



Shop-made welding jig.

Two other short pieces of the same flat iron stock are cut long enough to span the outer edge of each side of the longer piece and the outer edge of the ring. Each of these are welded at the ends, thus forming a four-spoked wheel.



A piece of 1¼-inch pipe, 6 inches long is welded to the back side of the wheel at the center of the ring to form an axle for the jig. Over this 1¼-inch pipe axle, a loose-fitting sleeve of 1½-inch pipe, 5 inches long, is fitted. The sleeve is held in place by a heavy washer which is welded to the axle to serve as a shoulder. Four elongated slots are cut in the longer flat iron strip to facilitate clamping any size flange to the jig.

By clamping the sleeve end in a stationary pipe vise, the circular part of the jig is free to rotate on its axle. The flange is secured to the jig by means of the two bolts. After centering the flange and tightening it to the circular part of the jig, the welder can make a bead faster because the flange and circular part of the jig can be turned manually.

At the formal opening of the Esso Training Center in Elizabeth, New Jersey, on January 22, (left to right) M. J. Rathbone, president of Standard Oil Company of New Jersey, R. T. Stoner, director of industrial education, Pennsylvania State Department of Education, and C. R. Dooley, sponsor of the Training-Within-Industry Foundation, inspect one of the many scale-model exhibits used in the training of employes in various phases of the company's operations. Augmenting an expanding program, the center is manned by 18 instructors and is equipped with the latest aids and devices.

Substitute Check Valve Prevents Shutdown

THE compressor in a Pennsylvania refinery is a two-stage, horizontal gas-engine-driven type, compressing vapors for polymerization. When a manufacturer was unable to make immediate delivery of a replacement discharge check valve, the operator devised a substitute valve of materials on hand to prevent a shutdown of the compressor.

The discharge valve of the compressor is of the disk type, spring loaded, and is easily removed and replaced after cleaning. A new cage for one of these valves was used in building the substitute check valve. A pipe spool was fitted with bolted flanges and inserted in the discharge line as the seat for the valve. A chamber milled in the discharge line accommodates the new cage, and the flanges maintain sufficient pressure to prevent the cage from moving. The substitute check valve, although recommended for temporary use, provides an effective non-chattering check valve of the same size and capacity of the valve it replaced.

ABOUT OUR AUTHORS..... and Other PERSONALITIES

Well to Engine

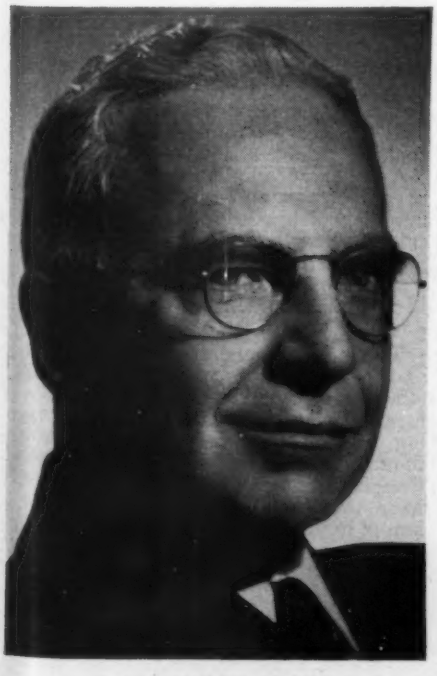
Early this year V. A. Kalichevsky, frequent contributor to PETROLEUM REFINER, will have another book on sale. This one, "From Oil Well to Engine" was written to meet the demand of the public, interested in all phases of the petroleum industry. This book will take a place alongside of another popular work on the industry, "The Amazing Petroleum Industry," published in 1943. Technical books from the Kalichevsky workshop are "Chemical Refining of Petroleum," "Modern Methods of Refining Lubricating Oils," as well as numerous magazine contributions and papers before technical societies.

Since 1944 Kalichevsky has been a consulting chemical engineer with Magnolia Petroleum Company at Beaumont. In addition to his writing, he has served as councilor and chairman of the Texas-Louisiana Gulf Coast Section of the American Chemical Society for 1946-47.

Kalichevsky has been connected with the refining industry since his graduation from California Institute of Technology as a bachelor of science in chemical engineering in 1924. He was born in Russia, the son of General Anatole J. Kalichevsky and his early education was on the Corps of Pages, His Imperial Majesty, Emperor of Russia.

Following World War I in which he served as captain in the Imperial Russian Guards, he fought against the Bolshevists in the White Russian Army of Admiral Kolchak in Siberia in 1919-20. Then followed a year as manager of the topographical department, Chukotak Peninsula Mining Corporation, Tokyo, Japan. before he came to the United States for further scientific studies.

After graduation from California Institute of Technology, he was with Union Oil Company for five years as a research chemist. Then came two years with Standard Oil Development Company. In 1931 he joined the Socony-Vacuum Oil Company as section supervisor and in 1937 he became general supervisor of the research and development division. He served in this capacity at Paulsboro until 1944 when he came to his present post with Magnolia Petroleum Company.



V. A. KALICHEVSKY

Burning Problem

An intended approach to giving advance information on an article "Refinery Gas Fuels" had to be abandoned because a search of our files revealed that some correspondence had been misplaced. The approach was to have been based on a count of the letters that pass back and forth between an author and an editor before a manuscript is ready for publication.

The file revealed information on L. A. Mekler, one of the authors and the one with whom correspondence has accumulated. But we had misplaced the material on C. G. von Fredersdorff, assistant chemical engineer at the Institute of Gas Technology, Chicago, who was in on the writing job, which began when Mekler was engineering consultant at Armour Research Foundation. More recently he has set up as consulting engineer, as reported in one of the recent issues of PETROLEUM REFINER.

One reason for an extensive correspondence file in the preparation of this article was the necessity of going to the industry for some basic information on refinery gas fuels now in use. Engineers and chemists responded and in most instances gave approval to the plan for presenting the inforation, which is now set down on 14 pages of proof paper, which is ready for sending to the authors for a second reading ahead of publication.

"Refinery Gas Fuels" had its start under another title, "Combustion Characteristics of Refinery Fuel Gases," and the information from the industry revealed that actual determination of the value of these gases for fuel purposes has been assumed rather than calculated.

Mekler has devoted the most of his time in petroleum engineering circles to furnace design, combustion and related problems. A native of Russia, his education includes degrees from the Russian Junior College, Harbin, Manchuria, the University of Glascow and the University of California. After two years in consulting work in California he joined the staff of Universal Oil Products Company in 1919. In 1921 he returned to consulting work but was back with UOP in 1927, where he remained until 1945, when he went to Armour Institute as a consulting engineer. He now has headquarters at 21 East Van Buren Street, Chicago.

He holds more than 50 Uuited States and foreign patents covering applications of heat to petroleum-refining processes. He has made frequent contributions to the technical magazines as well as through appearances before the professional societies.

L. A. MEKLER

"Refinery Gas Fuels" appears in this issue of PETROLEUM REFINER.

More Hot Stuff

"This series has been written especially for engineers working in the petroleum and related process industries"—a sentence from the summary for publication along with the first of a series of eighteen articles on "Applications of Thermodynamics to Hydrocarbon Processing," which Wayne C. Edmister has in preparation.

Edmister joined Delner Corporation, a subsidiary of Hydrocarbon Research, Inc., January 15, 1947, as senior chemical engineer. The concern has been awarded the architect-engineering contract for the facilities at the Brookhaven National Laboratory, a regional research center in nuclear physics under the direction of the Atomic Energy Commission.

Thermodynamics has been his major interest since he was a student at Oklahoma A. & M. College, for his first article on the subject was published in that period. His industrial experience includes connections with Standard Oil Company (Indiana), Rubber Reserve Company and Foster Wheeler Corporation, where he was a senior process engineer until making his present connection.

While a resident of the Chicago area he engaged in part-time teaching of advanced chemical engineering at the Illinois Institute of Technology and gave

WAYNE C. EDMISTER

instruction in refining process design at Whiting, Indiana, for classes within the personnel of Standard Oil Company (Indiana). The series on thermodynamics, now in preparation, is the outgrowth of the courses given during this period.

Getting the writing job finished is difficult. Over the past few months Edmister has been wont to take an airplane for some spot in Europe or South America and his letters and the photographs he sends or brings back are proof that the tall boy from Oklahoma has interests more extensive than mathematics and chemistry.

In addition to undergraduate work at the Oklahoma school, Edmister has done graduate work at Cornell University, the University of Chicago and at Illinois Institute of Technology. His technical contributions in the literature have been frequent and of a quality that has resulted in many requests that he be induced to give thermodynamics a complete presentation in one series of articles.

And all of this is simply to report that this series is in the state of preparation, several chapters complete, except for proof reading, and a recent letter from the author indicated that he would give the go signal this year.

To The Printer

B. H. Weil reports that his book on the Synthine Process, an expansion of the four articles in recent issues of PETROLEUM REFINER, now is in the hands of the printer and due for release in May. Weil and John C. Lane contributed the four articles, having worked together in the information division of Gulf Research & Development Company before Weil became head of the Technical information Division of Georgia School of Technology.

When the first of the four articles appeared inquiries as to availability of reprints arrived. Since the book is being printed, it has been decided not to make reprints, as the book will be a thorough presentation on the subject of gas synthesis, generally known as the Fischer-Tropsch process.

Robert P. Russell Gets Cadman Memorial Award

The Cadman Memorial Medal for outstanding research in petroleum science has been awarded to Robert P. Russell, president of Standard Oil Development Company, it was announced January 21 by the Institute of Petroleum in London.

The Cadman medal is awarded at least once every three years for scientific contributions in the field of petroleum. Russell will receive the medal June 4 when he delivers the second Cadman Memorial Lecture in the Lecture Hall of the Royal Institution, London. He will speak on "Progress in Petroleum Research."

The medal, first awarded in 1946 to Sir William Fraser, C. B. E., commemorates the services to the petroleum industry of the late Lord Cadman.

As head of the central technical and research organization of Standard Oil Company (New Jersey), Russell guides the work of 2000 chemists, engineers and technologists, who, operating as a team, have made major contributions to the development of new processes and new and improved petroleum products.

In recognition of his services during the war, particularly in directing research and development in the field of flame throwers, incendiaries and smoke generators, Russell recently was awarded the Medal for Merit, the highest civilian award in the United States. Citing him for "especially meritorious conduct in the performance of outstanding services," President Truman said that his "untiring efforts and successful results reflect great credit on himself and the nation."

R. P. RUSSELL

The American Institute of Chemists, recognizing Russell's wartime achievement in directing the development of aircraft fuels, explosives and synthetic rubber, recently awarded him the institute's 1946 gold medal for "noteworthy and outstanding service to the science of chemistry."

His abilities as a scientist and as an inspiring leader of men have helped Russell become the chief executive of one of the largest petroleum research organizations in the world. Born in Worcester, Massachusetts, in 1898, he attended Clark University, helping to pay for his education by an odd assortment of jobs which included work on the production line in a woolen mill and house-to-house selling of brushes. During summers, he worked as a deckhand on sailing vessels.

His university studies were interrupted when he joined the United States Marines in the First World War. After military service he entered Massachusetts Institute of Technology to study chemical engineering. He received his master's degree in 1923 and remained at the institution as assistant director of the research laboratory and as assistant professor of chemical engineering.

Russell began his career with Standard Oil Company (New Jersey) in 1927, as director of the newly established research laboratories at Baton Rouge, Louisiana. He started research on hydrogenation and the possibilities of making synthetic products from petroleum. A pioneer in the work of petroleum hydrogenation, he has been associated since with every advance in this field in the United States.

In 1929, he became vice president and general manager of Hydro Engineering and Chemical Company (an affiliate) and five years later, vice president and general manager of Standard Oil Development Company. He participated in the World Petroleum Congress in Paris in 1937, and later was named executive vice president of the company.

Some of the company's achievements under Russell's direction include development of the Fluid Catalytic cracking process.

Another war project was the development of a process of synthesizing toluene from petroleum, enabling an output of unlimited and unprecedented quantities of toluene for TNT at about one-fifth the cost of toluene produced from coal.

Another accomplishment was the discovery of a catalytic process for making butadiene from petroleum for synthetic rubber. Nearly 90 percent of the United States wartime butadiene made from petroleum came from the process which Mr. Russell guided into large-scale production.

The smoke generator which Russell and his associates designed was used effectively to screen Allied troop movements. Use of the generator's dense, lasting oil fog was credited with saving thousands of lives. Among other wartime developments under his supervision were the famed M-69 aerial incendiary bomb, improved flame throwers and special oils.

In addition to seeking new and improved uses for crude oil, Russell currently is directing work on the production of liquid hydrocarbons from coal and natural gas, on better synthetic rubbers, and in the field of plastics.

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MICRO FLUTE

Flow characteristics..

Rangeability 40 to 1...5 Sizes give Uniform Capacity
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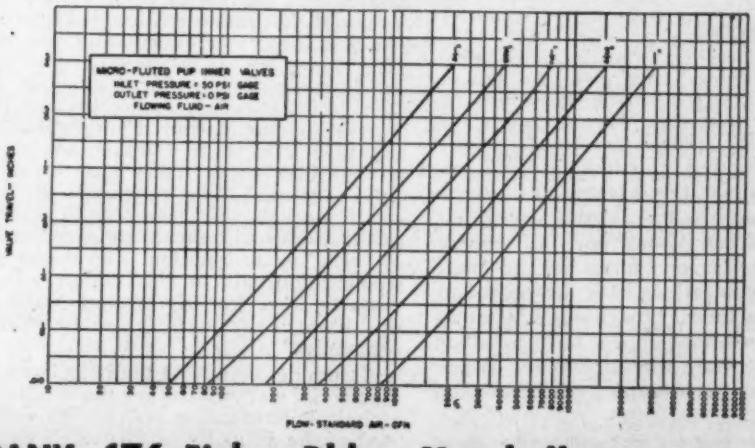

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Information Service and The Petroleum Industry

B. H. WEIL, Chief, Technical Information Division,
State Engineering Experiment Station, Georgia School of Technology

SCIENTIFIC and technologic developments of the past few decades have presented the petroleum industry with a wealth of published information for use in its highly-technical, extremely diverse operations. Many petroleum companies have provided information-service groups to interpret this data, as needed, and to condense, in a usable manner, the flow of current information. Such service groups, where properly staffed, also can aid in patent work, editing, advertising, and other correlated activities. These services, however, often are beyond the means of the smaller companies, and much needless duplication could be avoided by some organized form of inter-company cooperation. In any case, the increasing flow of published information indicates an ever-greater need for technical-information services.

The author was the founder and for five years the head of the Information Section of the Chemistry Division of Gulf Research & Development Company. He is now chief of the Technical Information Division of the State Engineering Experiment Station, Georgia School of Technology, where his duties are concerned with information work, patents, and publications, including editorship of *The Research Engineer*. He is joint author of a series of articles on the Synthine Process, which appeared last year in *Petroleum Refiner*, and has written many other articles on petroleum related subjects. He is also senior author of the recent book, "Plastic Horizons."

NOW that the petroleum industry has returned to its peacetime operations, it has had time to realize that it has become an exceedingly complex technical industry, replete with ramifications in all of the fields of science and engineering. Crude as our present scientific data may seem to later generations, it is still true that a vast amount of scientific and technologic information has accrued from the work of scientists and engineers over the past few decades. Reports of this work, however, contained in the periodical literature and in patents, now threaten to become so voluminous on any subject that many technical industries are at a loss to take proper advantage of it, often preferring instead to rely on additional laboratory work in order to obtain information which may or may not be available in the literature and which might or might not be located by the staff at hand.

The recent war has served to develop in the petroleum industry a definite awareness that its operations require technical information of many types on many subjects. For example, one of the chief functions of the Technical Advisory Committee to the Petroleum Industry War Council was the dissemination of varied technical information, in the form of reports, to those companies which, under secrecy orders, could utilize the data therein to produce better and larger amounts of military products. Other war-agency committees served similar purposes, and almost every petroleum company can testify to the fact that it was deluged with numerous reports on important aspects of many technical subjects. The dissemination of this information to the actual workers inside any company was in itself a major task, since it was obvious that no one technical worker could properly read and apply all of the available information. Furthermore, when it is considered that such reports were additional knowledge in fields which were in many cases already complex, it may well be understood that the organized provision of technical information became an acute necessity for those companies which were conducting research projects as well as manufacturing operations.

Information work in the petroleum industry is far from new, of course [1, 3, 4, 7]. The larger companies and engineering organizations have for years had excellent technical libraries and information groups whose duty it is to correlate and to distribute the information which appears in the literature or which had appeared there in the past. Each of these staffs has had to struggle with the need for an adequate indexing system, the importance of getting information to the right workers at the right time, and the necessity for obtaining adequate information on a sufficient variety of subjects well in advance of the need for such knowledge, without expenditure of exorbitant sums of money.

The smaller companies, with less adequate funds, have struggled unsuccessfully to provide complete information services, having to rely instead upon less elaborate libraries and such complete or semi-complete searches as their usually inadequate library staffs can provide in the time available. Many of these companies, it is true, depend upon the large engineering organizations for the development and operating details of processes which they apply in their operations, hence do not need the same volume of information as is required by those companies who are developing certain processes and attempting to discover others. Nevertheless, it is important to all companies that they be aware of the technical and economic background of the industry as a whole and of the processes which provide the basis of operations. Similarly, it is important to the individual scientific worker in the petroleum industry to keep abreast of technical developments in his own specialities and in those which are related to them.

The primary sources of technical information, of course, are periodicals, books, and patents.* The secondary sources of technical information are the abstract bulletins prepared by various societies and companies. In petroleum chemistry, for example, the useful abstract journals are *Chemical Abstracts*, *British Chemical Abstracts*, the *Chemisches Zentralblatt*, the *Engineering Index*, the *Industrial Arts Index*, etc. Returning to the primary sources of information, we find that there are thousands of journals which relate to scientific topics and to their technologic applications. Even the largest companies find it impossible to consider all of these journals, and must instead deal chiefly with those of major importance and then rely upon the abstract journals to locate related articles in those journals which are not usually so "rich" in information. The useful petroleum journals in this country, incidentally, have recently been analyzed by the library of one of our petroleum companies.[8]

Assuming, then, that the petroleum industry is well aware of the need for technical information and is also cognizant of the difficulty of adequately filling this requirement, it might be interesting to consider the problems involved in the provision of technical information in such a way that it can be used by the industry in an efficie nt manner. Recent symposia on technical-library techniques [1, 2, 5, 6], presented to the Division of Chemican Education of the American Chemical Society, have provided much data on general informational practices. The attendance and participation in these meetings of many of those who are charged with the task of providing information to petroleum organizations has indicated that these workers are well aware of the problems involved.

Current Information

There are two general methods by which an information service can help to keep a company abreast of current developments: the provision of summaries and the preparation of abstracts. The latter scheme is usually applied, since its operation requires only the ability to describe in a relatively small number of words the type and content of pertinent articles, books, and patents. Summaries, on the other hand, require that the information worker be familiar with the broad and detailed aspects of the field, so that the various new pieces of information can be fitted into the general picture with the proper emphasis. Many petroleum companies, therefore, have abstract bulletins which, under various logical systems, subdivide the literature which appears on various technical topics and present thereunder the pertinent facts contained in those articles which have appeared in the publication interval.

Where sufficient abstractors are not available, it is not at all uncommon that such bulletins comprise a selection of pertinent abstracts from such general sources as *Chemical Abstracts;* this method has the advantage that only one or two qualified people are required to

*EDITOR'S NOTE: The contribution of *Petroleum Refiner* to this need are the monthly departments *"Science and Technology Abstracts"* include *Digest of Recent United States Patents Pertaining to Petroleum Refining*. Obviously, the former cannot claim to include all chemical publications pertaining directly or remotely to refining of petroleum, but the listings of patents is the work of a competent and thorough researcher.

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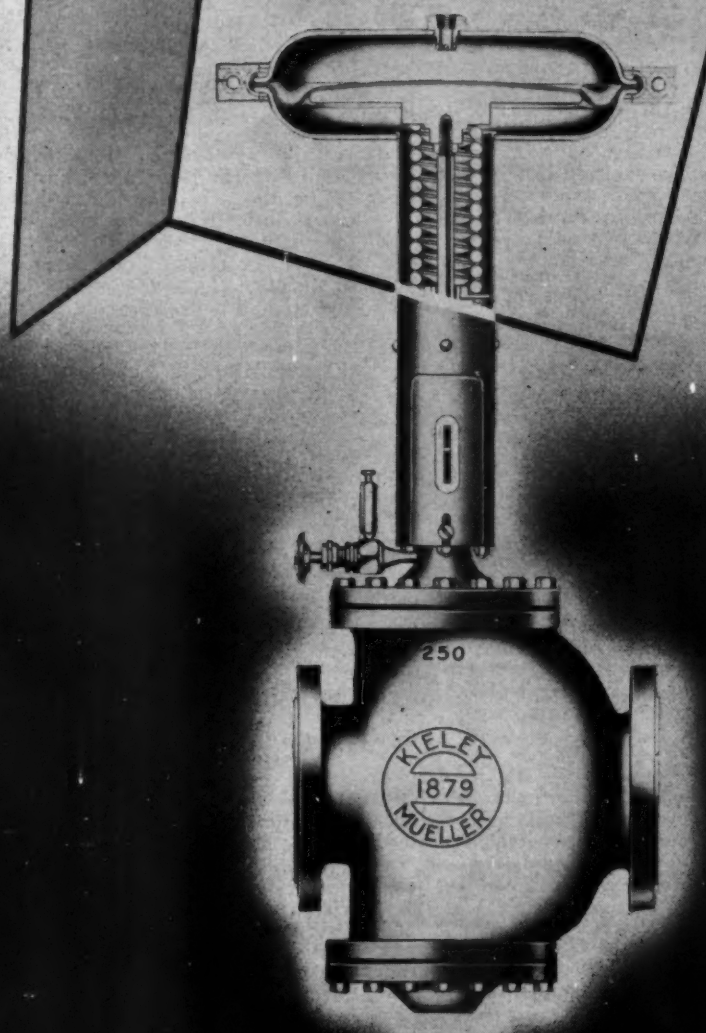

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check completely each issue of *Chemical Abstracts*, which naturally relates to many fields other than petroleum chemistry, and that, thereafter, every reader has available the "cream of the crop."

This latter technique is relatively satisfactory where the time lag following publication is not too important, since it is obvious that it adds a few days or weeks or months already required before an abstract of an article or patent can appear. Similarly, it does not take into account the fact that *Chemical Abstracts* does not abstract in detail, or at all, certain publications which are of definite interest to petroleum operations, even though their pertinency to chemistry may be rather remote. One petroleum company, for example, has supplemented such a bulletin with a "Weekly Literature Notification Bulletin," which is prepared directly from a continuous literature survey and which contains, under a reasonable number of classifications and with reasonable cross-referencing, the title, author, journal, date, and page reference to all technical articles relating to petroleum which have appeared during the week. In this manner, those workers on particular subjects who must keep abreast of current information will have some conception of what is new in their field; if it does not appear urgent that the worker consult the original reference, he can then afford to wait until the abstract is reported in the bulletin based upon *Chemical Abstracts*.

In regard to patents, many companies follow different procedures. One company, based on the receipt from the Patent Office of all patents in the petroleum classifications and certain related classifications, and upon a week-by-week check through the *Patent Gazette*, circulates the patents obtained to a number of workers in the research laboratories who are assigned to prepare abstracts on those patents which relate to their interests. These abstracts are then returned to the central office, classified, and periodically reproduced in a bulletin which is sent to all the technical workers of the company. The abstracts are also classified and cross-classified under a logical system, thus yielding a continuous file of information on all topics of present and potential interest.

Another company prepares a patent-abstract bulletin directly from the claim-type abstracts which appear in the *Patent Gazette*, then classifies the actual patents under all the subjects which appear related; a record book is kept of these classifications. Still other techniques, or combinations of these, are followed by other companies.

The practice of issuing technical summaries is not so prevalent in the petroleum industry, since adequate interpretation of the information usually requires careful analysis by the technologists themselves. One company, however, at one time instituted the preparation of a "Monthly Summary of Industrial Developments," which summarized those technical-economic-news developments of the month which were related to the petroleum industry in many of its ramifications, such as aviation gasoline, synthetic rubber, petroleum chemicals, automobiles, refinery construction news, etc. This was a general-purpose bulletin which was intended for use by management as well as technical personnel, and was based upon a continuous survey of both the technical and business journals.

As can be seen, abstract services of the type mentioned above serve two purposes: (1) the provision of information at the time of appearance, and (2) the accumulation of abstracted information on a variety of subjects for future use.

Information Searches

In many types of petroleum operations, and especially when such operations are in their inception and are being considered for research, it is often necessary to know what has been done before, so that a decision can be reached as to whether further work is desirable or even practical. In addition, such information is required to avoid patent entanglements and the expenditure of money on research which is unnecessary because of the existence of the required knowledge. It is in this field that information service plays its most important part, for it serves to interpret published knowledge in the light of the question at hand.

Here again several forms of presentation are possible. The information may be obtained by the literature searcher and summarized, with proper annotations, so that the question is answered to the best of the searcher's ability. Adequate documentation is of course required, so that any question as to the basis of such a decision can be referred to the source of information for possible confirmation or refutation. This technique is particularly valuable where a broad, general background is desired on a new process or product, or where, for example, specific physical data are required and can be located.

The other method is the provision of search reports, which are essentially annotated bibliographies. In this case, the literature searcher locates all of the pertinent literature, obtains or prepares abstracts thereof, and presents these abstracts in some logical arrangement with the required degree of indexing, depending upon the scope. This type of search requires that the user refer to the original literature for more detailed information upon which he then bases his own decision. In most cases, it is probably the preferable type of information report, since it is seldom desirable to have the literature searcher assume full responsibility for making technical decisions unless he is an authority.

Indexing

It is not pertinent here to discuss in detail the problem of indexing which is encountered by all users of the technical literature, both in the petroleum filed and elsewhere. Petroleum refining in particular is a very broad subject, extending as it does into chemical and mechanical technology, based upon all of the fundamental sciences. Many companies and workers have grappled with the problem of preparing an adequate, far-sighted index system, and several of these systems have been used rather widely. That most petroleum companies have recently had to revise their systems is indicative of the fact that no one system has yet proved generally acceptable. It is perfectly true, however, that any system can be used if proper attention is given to the classification of the literature and to the search for related classes when the files are being used.

It is unfortunate, however, that little opportunity has been provided for the various companies to consider this problem as a group and to select the best method from the various existing systems. It would certainly seem that the petroleum industry ought to consider the preparation of a generally acceptable system and the continued review thereof for such changes as would later be required to keep it up to date without destroying the master framework.

Use of Information

It is very easy for a company to provide so much information that the worker tends to ignore the offered services because they take more time than he has available. Almost every worker subscribes to a few or more journals, and the provision of information services must certainly not attempt to separate the scientist from contact with the primary sources of information. Instead, the function of an information service is to provide the worker with such knowledge as he may require and, as far as possible, with such background as he may care to acquire. For this reason, it is very desirable to have abstract bulletins divided by topics, so that the worker with little time will be able to refer directly and exclusively to those sections which are most pertinent to him. Similarly, even in the news-type summaries, it is important that these summaries be so divided by topic that the worker who is not interested in, for example, synthetic rubber, need not read the information on this subject.

The use of information becomes a more difficult problem when a search, for example, uncovers 3500 related articles and patents. Here, it is of prime importance that an adequate, cross-reference index be prepared, so that the worker can refer to one or more topics of immediate importance and relegate the acquisition of general information to such time as may later be afforded. It is highly desirable in such cases, of course, that the literature searcher prepare an informational summary of the field, if such is not already generally available, but an annotated summary as a sole coverage of the field usually would fail, by its very volume, to accomplish its purpose. This is not always true, of course, as may be witnessed by such texts as "The Hydrogenation of Organic Compounds," by Carlton Ellis, which is readily usable by the scientist, but not every information section is staffed or has the time for work of this type.

Information Corollaries

A well-rounded information group is capable of performing many other functions than the direct provision of the information required previous to and during the performance of technical research and operations. Since a knowledge of patents is necessary for the proper provision of complete information searches, it is not at all uncommon to find informational groups serving as correlative agencies for the collection of patentable ideas on actual laboratory operations and the provision of this information, through a sort of middle-man function, to such patent attorneys as the company may employ or contain.

Information service often enables the workers providing it to become reasonably well acquainted with the entire functioning of the company involved. Even where this group is simply a part of the research laboratory, it may often provide yeoman service to the sales and advertising divisions of the company by serving as interpreters for the developments achieved. Advertising often is considered just a little beneath the dignity of the average technical man, but for the good of the company for which he works he must be willing to cooperate, especially if he does not wish to see his

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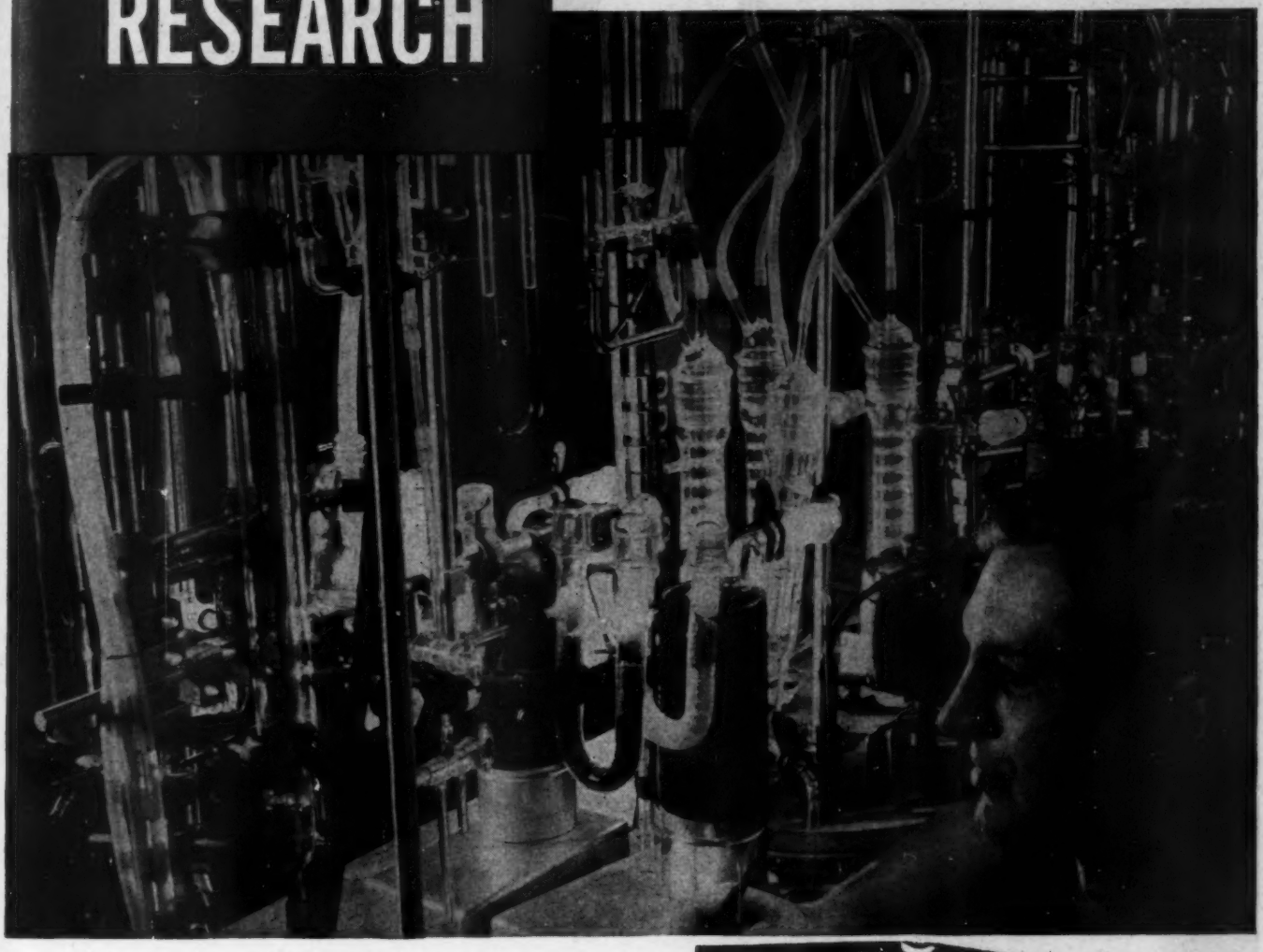

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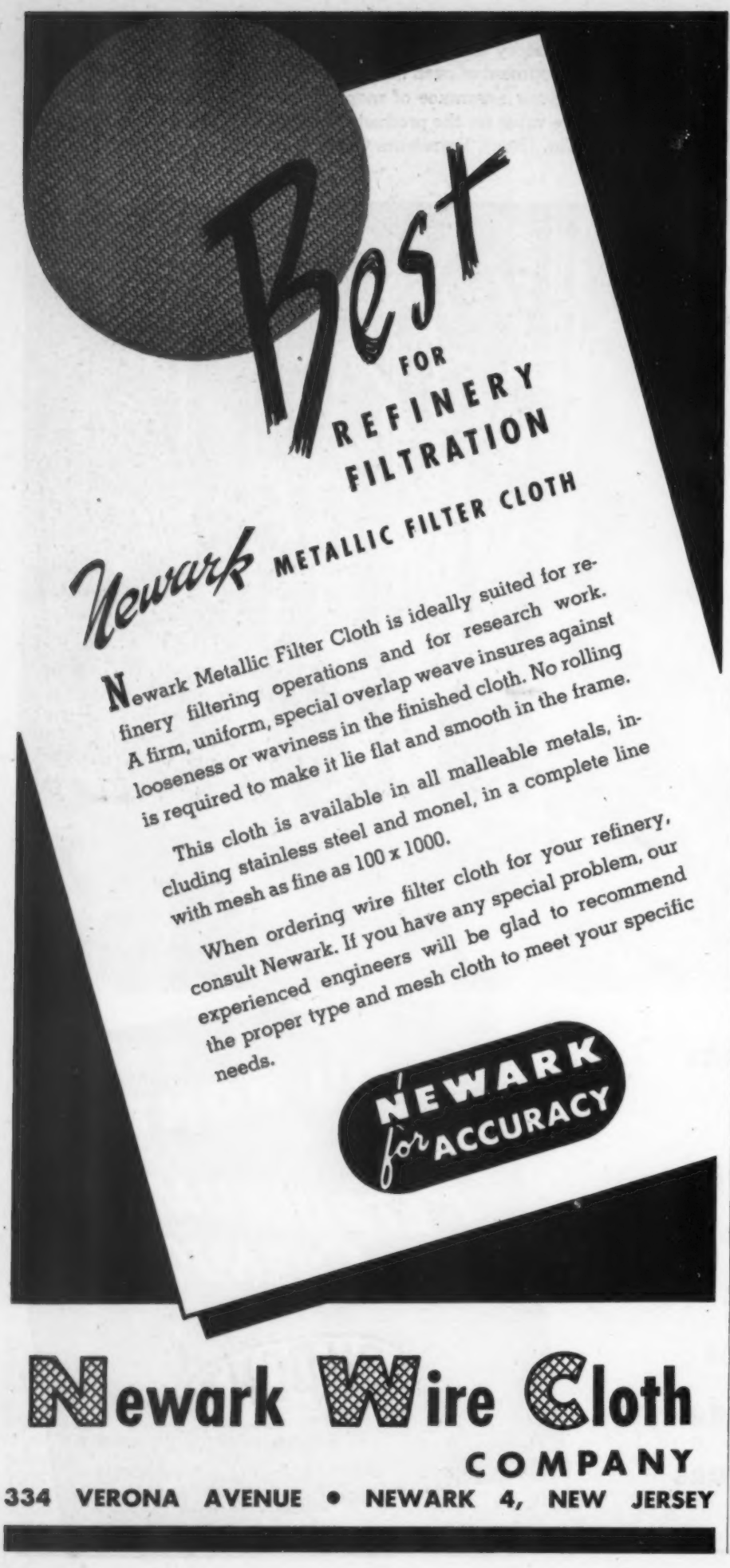
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achievements misinterpreted and misrepresented to the public. Informational groups, who must of necessity acquire a broad understanding of economics as well as science, are logical agencies to serve as coordinators for this purpose.

Many petroleum companies, have realized that the general dissemination of such information as will not alter competitive positions is a highly desirable practice since, if encouraged, it will cause other companies to pursue a similar course. In general, information services summarize knowledge which is available generally but not in the desired form. After this information has served the purpose for which it was gathered, these aforementioned enlightened companies often permit the information workers to present it in the form of papers which may be published in the journals of technical societies or in various trade and technical journals. This policy is often a considerable inducement to the information worker, who many times is interested and trained in writing since he must always present the information required in the form of written reports. Unlike a laboratory worker, he seldom or never performs original research so that, if he is never permitted to make use of such commonly available information as comes to his attention, he can never acquire the same stature as workers of similar ability who are employed in laboratory operations. In cases where writing ability is marked, and when the ability to edit is also characteristic, information workers sometimes find themselves requested to prepare popular or semi-technical articles for company journals, to edit speeches prepared by research executives, and even to address such nontechnical groups as luncheon clubs, chambers of commerce, etc., on technical topics.

Personnel

It is not to be expected, of course, that every information worker will have the ability and training to enable him to perform all of the functions which have been mentioned so far. The day is passing, however, when a company desiring an information worker may insert an advertisement stating: "Wanted, library worker, preferably a woman, to operate a technical library. Abstracting, filing, etc., also involved. Typing ability required, also knowledge of German and French." Such paragons, also, usually were expected to be available at no more than $150 per month.

It is true that the average small company cannot afford a much more elaborate, on-the-ground service than that just parodied, but any company will do well to consider the trend toward the use of technically-trained, library-wise scientists for the proper conductance of technical information services[3] and to disassociate from such workers, as much as possible, such routine tasks as typing and filing, although the latter, of necessity, is often a technical function.

For proper conductance of informational activities, a worker should have adequate technical training, an interest in learning for its own sake, knowledge of the use of libraries, the ability to express himself in writing, and the initiative to see that the results of his searching are used insofar as is possible. Not every worker need have all these qualifications, but the successful information worker must have the majority of them.

There is need for adequate correlation of information services with research or

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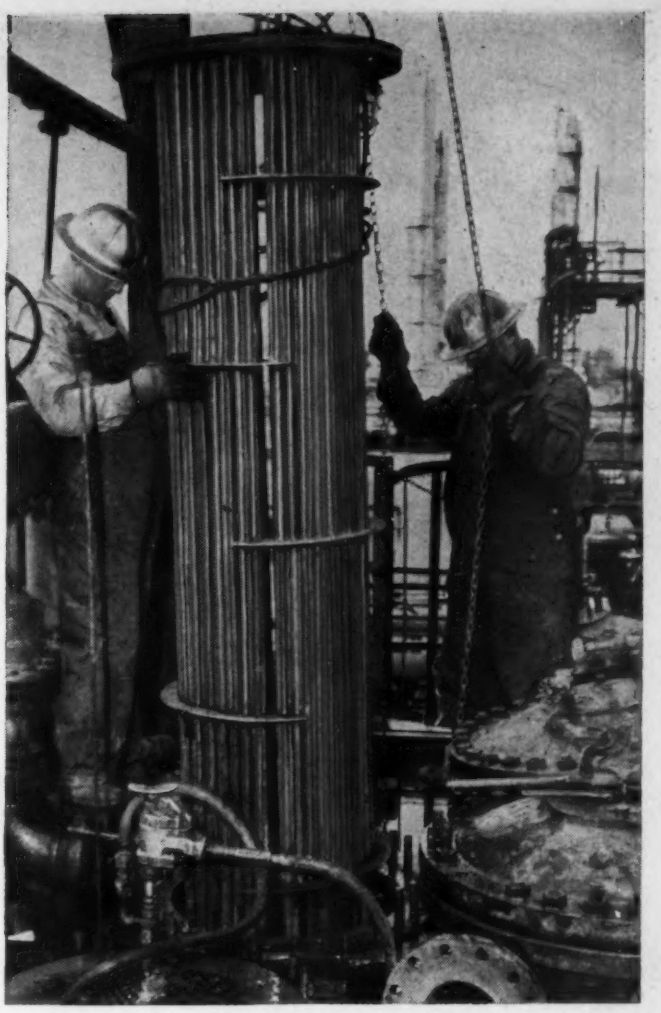

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Super-Nickel	Deoxidized Arsenical Copper
	Deoxidized Copper

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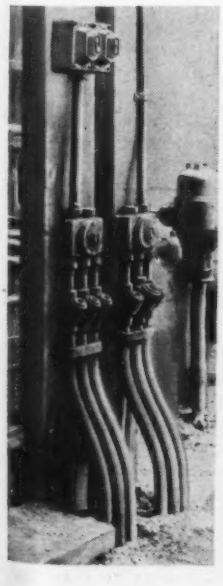

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operational management. It is highly desirable that the information workers have a clear understanding of the potential use of the information which they may be requested to provide. In many cases, it is advantageous to have the director of an information section attend the meetings on research planning; it is even possible that he may occasionally have information on hand which will guide decisions at such meetings, thus avoiding the necessity for changes at a later date. Those conducting research projects do not always realize the advantages inherent in not having to ask for information, since they do not always know that such information exists or may be made available.

Inside the section itself, it is highly desirable that each worker have clearly defined functions, although it is equally necessary that these workers be able to perform a variety of tasks so that, when speed is required, several may be employed on a single project with a minimum of confusion and inefficiency.

In all cases, it is necessary that the qualified information worker be compensated at an equivalent rate to his laboratory brother of equal ability. Informational work is a service function, incidentally, and laboratory and operational workers should realize that the specialists in this field are not, in a direct sense, competitive with them, nor are they attempting to "steal their glory."

Future Informational Trends

It is beyond refutation that the literature of the future will be even more voluminous than that of the past. The technical industries are at present engulfed in a flood of German data being released by the Office of the Publication Board, and many papers on topics which were restricted during the war now are appearing. Furthermore, the Russian literature is increasing rapidly in quantity and in importance. It is obvious, then, that information services will be required on a far greater scale than has ever before been true. It is for this reason that every petroleum company should consider the extent and functions of its present information services and the desirability of future changes, so that these groups can serve in an efficient manner in the years to come.

It is perhaps unfortunate that there is at present so little cooperation between petroleum companies on informational matters. Competition demands that technical accomplishments be kept secret until such time as they are protected by patents and available for licensing, if the latter is decided upon. For this reason, it is often necessary, also, to restrict the knowledge that a search has been made on a subject in order to prevent competitors from becoming aware that this field may be of potential importance. Nevertheless, many companies have had to prepare detailed information searches on the same topics—catalytic cracking, isomerization, alkylation, hydrogenation, the synthine process, etc., in addition to searches on many other subjects of technical importance which relate to these and other operations. Such duplications have been vastly expensive, although not generally realized. Similarly, the provision of current information services by the several companies is certainly duplicatory in nature, and there is the attendant undesirable feature that many companies, especially the smaller ones, do not provide such services to their personnel.

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BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

methods for remedying the deficiencies in the present picture. An ideal arrangement, of course, would call for a pooling of existing informational searches and files, the arrangement of this material under a generally-acceptable system, and the central provision of future information to all who are contributing members. Such a group, of course, would have to be disassociated from any one company and would have to be extremely reliable, so that no hint would be given to competitors in regard to the interest by a company in a certain topic.

For best results, such a central agency would not replace but would instead supplement the existing or potential information services of the various companies, since these latter would be required for final interpretation of information in respect to the problems in question and for such projects as are considered desirable for local attention. Many more details would obviously have to be worked out, and no attempt is made here to more than indicate the possibility.

In any case, the petroleum industry is already alert to the need for technical-information service. If the examples used here have been slanted heavily toward petroleum refining, it is because the writer is chiefly experienced in that field; petroleum exploration and production also lean heavily upon technical information in their operations. The provision of information in a logical manner must keep pace with advancing technology or the latter will lose its effectiveness. The scientist must not be permitted to throw up his hands in despair at the extent of the available published information and then be allowed to retire to his laboratory to duplicate this information rather than to attempt, perhaps in vain, to locate it. Information service, whether as a part of a library or of the actual laboratory set-up, must be used as the interpreter of published information for the scientist and executive.

Acknowledgments

Grateful acknowledgment is made to Mr. Eugene Ayres, chief chemist, and Dr. Paul D. Foote, director of Gulf Research & Development Company, for their encouragement and cooperation during the years following the inception of an information section in the Chemistry Division of that company, also to Mr. John C. Lane, head of that information section, for his criticisms and suggestions on this paper. Acknowledgments also are due to Dr. Gerald A. Rosselot, director, and to Dr. Paul Weber, assistant director of the State Engineering Experiment Station, Georgia School of Technology, for their interest in and permission to prepare this paper.

BIBLIOGRAPHY

[1] Alexander, M., Corbin, N., and Egloff, G., *Journal of Chemical Education 21*, No. 12, 615 (1944), "Scholastic Training for a Career in Chemical Literature Research."

[2] Egloff, G., Alexander, M., and Van Arsdell, P., *Journal of Chemical Education 20*, No. 8, 393 (1943), "Problems of the Scientific Literature Survey."

[3] Rocq, M. M., Nutting, E., and Karpenstein, K., *Special Libraries 36*, No. 8, 376 (1945), "Petroleum Periodicals."

[4] Schaler, C., *Oil and Gas Journal 40*, No. 22, 52 (1941), "Maintenance of Information for Refining Patent Department."

[5] "Symposium on Technical Library Techniques," *Journal of Chemical Education 20*, No.'s 11, 12 (1943).

[6] "Symposium No. 2 on Technical Library Techniques," *Journal of Chemical Education 21*, No.'s 6, 7 (1944).

[7] Weil, B. H., and Deitch, W. H., *Chemical and Engineering News 22*, No. 10, 808 (1944), "Information Service and the War Effort."

THE MONTH IN THE INDUSTRY

WPRA Shaping Program For San Antonio Meeting

Two technical sessions will make up a part of the anual program of the annual meeting of Western Petroleum Refiners Association to be held March 24, 25, and 26, in San Antonio. All sessions will be in the Plaza Hotel. Although speakers have not been designated these technical sessions will cover such subjects as petro-chemical processing, adaptations of the Fischer-Tropsch process, catalytic cracking, as well as consideration of octane rating and automotive-engine performance.

Among the speakers at general sessions will be Governor Beauford Jester of Texas who will deliver the address of welcome. John L. McCaffrey, president of International Harvester Company, will deal with the relationship between the petroleum industry and the agricultural industry.

Three entertainment features are on the program. Ethyl Corporation will be host at a buffet dinner the evening of March 23. Another buffet dinner will be served Tuesday night by the combined effort of supply and service companies, whose products are used in refining. The association's dinner dance will be held the evening of March 25.

This will be the thirty-fifth annual meeting of the association. In a recent letter John C. Day, secretary, reported on an exceptional advance request for rooms in the San Antonio hotels.

Chemists Discuss Lubricant Additives

The Texas-Louisiana-Gulf Section of The American Chemical Society met at Port Arthur January 16 for its first 1947 session. V. A. Kalichevsky, section chairman, presided. The principal speaker, F. L. Matthews, Coordinator of Production, Sales, and Research of Petroleum Additives for Monsanto Chemical Company, was introduced by N. B. Haskell, a vice chairman of the section.

Dr. Matthews discussed the use of various additives for the depression of pour points in the blending of engine lubricants, for increasing oxygen stability and reducing bearing corrosion, and for increasing resistance to the formation of sludges and lacquers. Testing of hypoid-gear lubricants and additives under conditions of low-speed high-load operation as well as the usual high-speed tests, were discussed briefly. Color slides illustrating test results on engine pistons and bearings, and on hypoid gears, were shown, and furnished very convincing argument in favor of additives in those specific instances. Dr. Matthews explained that fitting the best additive to a particular lubricating stock and application is largely a matter of "cut-and-try," with previous experience useful but not necessarily an accurate guide in estimating results, and actual laboratory and field testing a requisite for final conclusions.

General Alden H. Waitt, Chief of Chemical Corps, United States Army, is to be the principal speaker for the next meeting of the Texas - Louisiana - Gulf Section at Beaumont, February 19 at 8 p. m. at Hotel Beaumont, and will be preceded by a dinner which is scheduled for 6:45 p.m. General Waitt will present a speech on "The Present Status of Chemical Warfare and Our Chemical Corps Research and Development Program."

Western Refiners Discuss Problems at Shreveport

A technical meeting of the question-and-answer type was held at Shreveport by the Western Refiners Association January 17. Questions were prepared in advance by the membership and a list was assembled by A. W. Trusty, Arkansas Fuel Oil Company, who conducted the meeting. A panel of experts participated in discussions of various subjects with the membership and included J. D. Waddell, superintendent of the Skelly Oil Company refinery at Longview, Texas; Harry Sheard of the Bayou State Oil Company, Hosston, Louisiana; L. A. Mekler, refinery consultant, Chicago; Hugh A. Neal, Phillips Petroleum Company, Bartlesville, Oklahoma; H. D. Noll, Houdry Processes Corporation, New York, and M. R. Schrein, Universal Oil Products Company, Chicago. Discussion centered largely about catalytic cracking possibilities and feed preparation methods, and about the prospects for dropping the doctor test from gasoline specifications. Corrosion of tankage and process equipment, the lead situation, lubricant additives, catalytically cracked diesel fuels, and octane testing of high vapor pressure fuels also were the subject of discussion.

CNGA Elects Dunn and Walker Board Members

W. Earl Dunn, The Fluor Corporation, and E. W. Walker, Western Gulf Oil Company, have been elected to the board of directors of California Natural Gasoline Association. They replace J. S. Fluor, Jr., and W. S. McAllister, resigned.

Dunn, following graduation from Michigan College of Mines, was employed by Petroleum Midway Oil Company during the construction of its gasoline plants at Montebello and Huntington Beach. Following that he spent a year with California Gasoline Company. In 1926 he joined the natural-gasoline division of Richfield Oil Corporation as superintendent of its Long Beach plants; later serving as construction superintendent. He resigned in 1930 to become associated with The Fluor Corporation, of which is now is vice president and general manager.

Walker, following graduation from Stanford University, spent several months with General Electric Company at Schenectady. In 1935 he returned to California to accept employment with the Kettleman Hills North Dome Association. In 1943, he became associated with Western Gulf Oil Company as a mechanical engineer at Bakersfield. When McAllister resigned recently to go to England. Walker was transferred to Los Angeles and placed in charge of the chief engineer's office.

Conventions

March

2-5—American Society of Mechanical Engineers, Mayo Hotel, Tulsa.
17-19—American Institute of Mining and Metallurgical Engineers, annual meeting, Waldorf-Astoria Hotel, New York.
17-19—American Society of Lubrication Engineers. Hotel William Penn, Pittsburgh.
24-26—Western Petroleum Refiners Association, annual membership meeting, San Antonio, Texas.
24-30—Oil Heat Institute of America, Traymore Hotel, Atlantic City, New Jersey.

April

7-10—National Association of Corrosion Engineers, Palmer House, Chicago.
23-25—Natural Gasoline Association of America, Baker Hotel, Dallas.
30-2—Natural Gas Department, American Gas Association, Stevens Hotel, Chicago.

May

4-7—Petroleum Equipment Suppliers Association, Mark Hopkins Hotel, San Francisco.
6-8—Petroleum Industry Electrical Association and Petroleum Electrical Supply Association, Rice Hotel, Houston.
6-8—Southwest Gas Measurement Short Course, University of Oklahoma, Norman.

June

23-25—American Chemical Society, Midwest Regional Meeting, Kansas City, Missouri.

September

15-17—National Butane-Propane Association, Jefferson Hotel, St. Louis.
29-3—American Gas Association, San Francisco.

October

21-25—Pacific Chemical Exposition, San Francisco.

November

10-13—American Petroleum Institute, Stevens Hotel, Chicago.

Supply Association Gets Set for NGAA Convention

In preparation for its activity of providing the entertainment for each annual meeting of the Natural Gasoline Association of America the affiliated Natural Gasoline Supply Men's Association has named committees to serve the several activities involved in the program. The convention will be held in Dallas, April 23, 24, and 25, with headquarters in the Baker Hotel.

The supply association will provide both the entertainment and the dinner as in past years.

Co-chairmen of the convention activities committee are Roy Bush, Nordstrom Valve Division of Rockwell Manufacturing Company, and John Heinzerling, Vision Supply Company.

Refreshment committee: C. C. Clover, Westcott & Greis, Inc., chairman; Joseph A. Coy, Joseph A. Coy Company; V. C. Canter, Jones & Laughlin Supply Company; M. A. Ellsworth, The Fluor Corporation; C. S. Greene, Greene Brothers, Inc.; Joe Massie, Henry Vogt Company.

Costume and service committee: Max E. Landry, Bruce-Macbeth Engine Company, chairman; L. S. Allen, National Tank Company; L. D. McKay, Union Steam Pump Sales Company; A. F. Canada, Jr., Pacific Pumps, Inc.;

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L. L. Dresser, Dresser Engineering Company; H. M. Rosevear, Wyatt Metal & Boiler Works.

Entertainment committee: Duman Perry, Perry Equipment Company, chairman; N. A. Endicott, Continental Supply Company; W. H. Lee, Ingersoll-Rand Company.

Dinner committee: Roy Bush, Nordstrom Valve Division, chairman; John Heinzerling, Frank P. Elizardi, A. M. Lockett & Company; R. E. Walker, Armco Drainage & Metal Products, Inc.

Ticket and registration committee: M. D. Gilbert, Pittsburgh Equitable Meter Division, Rockwell Manufacturing Company, chairman; M. E. Duncan, Johns-Manville Sales Corporation; W. H. Edwards, Superior Manufacturing Company; J. N. McClure, The Elliott Company; W. O. Moran, Moran Furnace & Sheet Metal Company; H. M. Nelly, Jr., J. F. Prichard & Company; C. B. Truitt, A. O. Smith Corporation; Louis Weiss, Sterns-Roger Manufacturing Company; Paul C. Wallack, Walco Engineering & Construction Company.

The supply association will hold its annual business meeting during the period and the following committee was named to make nominations: W. W. Woobank, Woobank Machinery Company, chairman; M. E. Duncan, Johns-Manville Sales Corporation; D. E. Field, Tulsa Boiler & Machinery Company.

Officials of the supply association are: Fred J .Wetzel, Ingersoll-Rand Company, president; John Heinzerling and Roy Bush, vice presidents; J. A. Knebel, H. K. Porter Company, treasurer. William F. Lowe is secretary of both organizations.

Lubrication Engineers Plan Pittsburgh Program

Preliminary announcement of program plans for the second annual convention of the American Society of Lubricating Engineers, scheduled for Pittsburgh, March 17-19, reveals papers are planned for four technical sessions. The program includes luncheon and banquet sessions as well.

Among speakers announced are Dr. T. C. Poulter, Armour Research Foundation, who will speak on "The Use of Extreme Pressure in the Study of Lubricating Oils"; H. Y. Hunsocker, Aluminum Company of America, "New Developments in Aluminum Alloy Bearings"; E. H. Erck, Bendix Aviation Corporation, "Instrument Lubrication"; John Boyd, Westinghouse Electric Corporation, "Jet Engine Bearings," and Eugene Lieber, Nox-Rust Chemical Corporation, "Mechanism of Preservation in Engine Oils."

Francis C. Savage Gets Socony-Vacuum Assignment

Francis C. Savage recently has been placed in charge of coordination of the lubricating-oil blending and compounding activities of Socony-Vacuum Oil Company. He also is handling special assignments in the manufacture of lubricating oils.

Before this promotion Savage was assistant technical director of Magnolia Petroleum Company, Beaumont.

Midwest Chemical Group Plans Petroleum Program

H. M. Steininger has been designated as secretary of the petroleum group meeting during the fifteenth Midwest Regional Meeting of the American Chemical Society to be held at Kansas City, Missouri, June 23, 24 and 25. In a letter soliciting papers for presentation, Steininger points out that the program will be one of general interest, and papers on chemical or chemical-engineering aspects of production, refining, utilization, etc., of petroleum or petroleum products will be acceptable. The regulations of the American Chemical Society governing papers will apply, and Steininger should be contacted by April 1, by those who might be interested in contributing to the program. His address is Standard Oil Company (Indiana), Sugar Creek, Missouri.

Oklahoma Section AICHE Elects 1947 Officials

Officials of the Oklahoma Location Section of the American Institute of Chemical Engineers were elected at the first dinner meeting, held in Bartlesville, January 24, 1947. Howard L. Malakoff was named chairman, with Virgil Scarth, vice chairman and Fred H. Poettmann, secretary-treasurer.

The meeting was the occasion for a talk by John J. Riley, Jr., Spencer Chemical Company, on "Peacetime Utilization of a War Plant." A motion picture showing the construction program of Jayhawk Ordnance Works was shown in conjunction with the talk.

H. R. Legatski, retiring section chairman was elected to the executive committee along with Harrison L. Hays and Lawrence K. Cecil.

New ACS Southwest Louisiana Section

A new section of the American Chemical Society has been formed in Lake Charles, Louisiana, to serve the considerable number of technical men of that area. For the past several years chemists and engineers in that area have participated in the activities of the Texas-Louisiana-Gulf section of the American Chemical Society which is largely composed of members located in the Beaumont-Port Arthur area, and monthly technical meetings have been held alternately in the three cities. Because of the distances involved, attendance at these meetings often has been difficult for the current "out-of-town" groups and this condition together with the increased number of technical men in the Lake Charles area has resulted in formation of the Southwest Louisiana Section.

JOHN B. DUCKWORTH

Dr. C. L. Brown Elected ACS Councilor-at-Large

Dr. Cecil L. Brown, director of the Esso Laboratories of the Standard Oil Company of New Jersey, Baton Rouge, has been elected a councilor-at-large of the American Chemical Society. A former chairman of the society's Division of Petroleum Chemistry, he will serve three years on the council, the society's advisory body on policy and general management. He represented the Baton Rouge section of the society as a councilor in 1941 and 1942.

Doctor Brown is a graduate of South Dakota State College, where he received the Bachelor of Science degree in 1919. He obtained the Master of Arts degree from the University of Missouri in 1922, and the Doctor of Philosophy degree from Brown University in 1930. He was an instructor at Rhode Island State College from 1924 to 1926, an assistant professor at Western State College, Colorado, in 1927-28, and an assistant professor at Louisiana State University in 1928 and 1929.

Author of numerous technical articles on aviation fuels and high-pressure hydrogenation, Dr. Brown is on the society's Committee on Professional and Economic Status and is a member of the American Association for the Advancement of Science, the American Institute of Chemical Engineers, American Petroleum Institute, and Sigma Xi.

Bludworth Resigns Celanese Post

Joseph E. Bludworth has resigned as director of hydrocarbon research for Celanese Corporation of America. He has entered the consulting field with headquarters in the Nixon building, Corpus Christi.

Bludworth was in charge of activities of Celanese Corporation from the time it began construction of the petrochemical plant at Chemcel, near Bishop, Texas. He had his first experience in the petroleum industry with the Chestnut and Smith Corporation, one of the pioneer producers of natural gasoline. Later he was a consulting engineer in refining with headquarters at Arlington, Texas. He joined Celanese Corporation in 1934 and went to Corpus Christi in 1943.

Indiana Standard Names Duckworth for Higher Post

John B. Duckworth has been made an assistant director of research of Standard Oil Company (Indiana). He has been a member of the research department since 1936, except for four years in military service with the power plant

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section of the Air Technical Service Command at Wright field, Dayton, Ohio. Duckworth received his bachelor of science degree in mechanical engineering from Purdue University and is a member of the Society of Automotive Engineers.

At Standard of Indiana's research laboratories at the Whiting, Indiana, refinery, F. S. Wood has been promoted to the position of group leader in charge of the lubricants group of the engine laboratory, E. L. Gregory has become mechanical supervisor with the rank of group leader in the engine laboratory, and Dr. J. C. Bailie has been advanced to assistant chief chemist.

Stratford Heads Texaco Development Corporation

William M. Stratford has been elected president of Texaco Development Corporation, to succeed R. J. Dearborn who has retired after 27 years with The Texas Company and the development corporation. William P. Gee and Charles F. Teichmann have been elected vice presidents of Texaco Development Corporation.

Stratford had a bachelor of science degree in chemical engineering from The Rice Institute and master of science degree from Massachusetts Institute of Technology, before he was employed in 1919 as a chemist for The Texas Company at Port Arthur. Later he was transferred to New York as patent attorney, and in 1933 was elected a vice president of Texaco Development Corporation.

Gee and Teichmann also started in The Texas Company laboratory at Port Arthur. Gee's connection with the development corporation began in 1934 when a program of licensing processes for manufacturing lubricating oil was started. Teichmann followed degrees in chemistry and chemical engineering at Columbia University with study of law,

W. H. STRATFORD

and was a patent attorney for The Texas Company before joining the development organization.

Enjay Company New Sales Subsidiary of Jersey

Enjay Company, Inc., has been formed as a subsidiary of Standard Oil Company (New Jersey), and will succeed in the activites of Standard Alcohol Company (which has been dissolved) and the chemical products department of Stanco, Inc.

H. W. Fisher, who was president of the alcohol company, is president of the new unit, with John A. Britton, Jr., formerly in charge of Stanco's chemical products department, and James G. Park, vice president and general sales manager of Standard Alcohol Company, as vice presidents.

Standard Oil Development Adds Three Vice Presidents

Standard Oil Development Company, central technical and research organization of Standard Oil Company (New Jersey) recently announced election of three new vice presidents and directors. The new officials were elected, it was explained, to help meet the requirements of an expanding research and development program.

The new officers, who increase the number of directors to 14, are Willard C. Asbury, who will be in charge of contract and patent activities, and E. Duer Reeves and Dr. William J. Sweeney, who will direct the company's work in research and development. Simultaneously, it was announced that William R. Carlisle, a vice president and director of Standard Oil Development Company, has been appointed associate general counsel of Jersey Standard. In addition to his new duties, he will remain a director of the development company.

Asbury is a graduate of Massachusetts Institute of Technology. He joined Standard Oil Company of Louisiana (affiliate), in 1927 and since 1929 has been with the development company.

Reeves is a graduate of Williams College and Princeton University. After a brief period in 1930 with Stanco Incorporated, he took graduate work in chemistry and then joined the Louisiana company in 1931. Since 1937 he has been with the development company.

Dr. Sweeney received a bachelor's degree in chemistry at Massachusetts State College and a master's degree in Inorganic Chemistry at Pennsylvania State College. In 1928, Massachusetts Institute of Technology awarded him a Doctor of Science degree in Chemical Engineering. Dr. Sweeney left a position as director of industrial research at Pennsylvania State College to join the Louisiana company in 1929 as a chemical engineer. He went with the development company in 1936 as an associate director of the Esso Laboratories.

Mr. Carlisle was graduated from

W. C. ASBURY

E. DUER REEVES

W. J. SWEENEY

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Oglethorpe University in 1920 and received his bachelor of laws degree from Columbia University in 1923. He was associated with the law firm of Davis, Polk, Wardwell, Gardiner and Reed until 1930 when he became legal assistant to the president of Standard Oil Development Company.

Taylor and Burke Promoted By Continental Oil Company

Appointment of Anderson W. Taylor to be superintendent, light oil division, Panca City refinery of Continental Oil Company, and promotion of Lawrence S. Burke to succeed Taylor as assistant superintendent, Glenrock refinery, were recently announced.

Taylor had several years' experience

L. S. BURKE

there as a refinery stillman before joining Continental Oil Company at the Wichita Falls refinery in 1919. In 1927 he was made a shipping clerk there and the following year became shift foreman. Promotions to be operator, and chief operator followed, and in 1942 he

A. W. TAYLOR

was made assistant superintendent at Glenrock refinery.

Burke attended the University of Nebraska, where he was graduated in 1939 with a degree in chemical engineering. He joined Continental Oil Company immediately as an analytical chemist at Ponca City, and was made resident chemist at Glenrock in 1941.

R. E. Luton Named Manager Of the Ohio Oil Refineries

Ray E. Luton has been appointed manager of refineries for The Ohio Oil Company. Formerly general superintendent of refineries, Luton will continue for the present at Robinson, Illinois, where he will have overall supervision of the company's refinery operations at Robinson and at Lovell, Wyoming.

Luton started with The Ohio Oil Company as assistant superintendent and chemist at the Robinson refinery in 1924 when the company acquired Lincoln Oil Refining Company. Subsequent to the dissolution of that company, he was appointed general superintendent of refineries in 1935. He is a member of the board of trustees of Western Petroleum Refiners Association and a member of the American Society for Testing Materials.

Whiting Refinery Project Groups Consolidated

The light-oil projects group and the heavy-oil projects group of the Whiting refinery of Standard Oil Company (Indiana) have been consolidated, and the consolidated groups now are known as the projects division, it was announced by Dr. W. J. McGill, refinery manager. Dr. R. T. Myrick, assistant to Dr. McGill, directs activities of the projects division, and Roy Diwoky is superintendent. J. A. Rueff is general foreman of light-oils projects, and P. E. Livesay is general foreman of heavy-oils projects.

J. C. Ducommun, assistant general superintendent of Whiting refinery, has been reassigned to executive work in connection with plant management; Charles F. Smith has been made assistant superintendent of the light-oils division, and G. H. Jones has been made general foreman of the catalytic-cracking department.

Arthur G. McKee Company Gets Hydrocol Contract

Contract for construction of the gas-synthesis plant of Carthage Hydrocol, Inc., near Brownsville, Texas, has been awarded to Arthur G. McKee Company, Cleveland, Ohio, which will serve as engineer and contractor. The plant will utilize the Hydrocol process, developed by Hydrocarbon Research, Inc., which is furnishing the basic designs for construction. The estimated cost of the plant is $16,000,000.

This plant will be the first to use natural gas a raw material for making motor fuel, diesel oil and several of the alcohols. It will be a development of the Fischer-Tropsch process, developed in Germany and used in providing motor fuel from raw material out of coal gasification.

The advancements provided by Hydrocarbon Research, Inc., include an adaptation of the Fluid catalytic cracking process for conversion of the synthesis gas to liquid.

Stanolind Progressing With Hugoton Synthol Plant

Engineering work is now in progress for construction of a large-scale Synthol plant for Stanolind Oil & Gas Company for processing natural gas of the Hugoton area, Western Kansas, into gasoline and distillate fuels. The plant is being designed on scale to process 100,000,000 cubic feet of dry gas daily, from which will be recovered 6000 barrels of gasoline daily as well as another 1000 barrels of other fuels. The announcement gives these details of design:

"The Hugoton plant is being designed to process low-heating-value gas currently unsuited for sale as fuel gas. An extensive gathering system and a natural-gasoline plant would be installed to provide the necessary volume of dry feed gas. In the process the feed gas is burned under 300 pounds pressure with relatively pure oxygen to yield synthesis gas with a composition controlled to within narrow limits. Oxygen for use in this step would be produced by fractionating liquid air in the largest plant ever constructed for this purpose. For each 15,000 cubic feet of gas charged to the plant, one barrel of crude synthetic oil and substantial amounts of oxygenated compounds (including alcohols, ketones, aldehydes and acids)

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1946:									
January 26	4,626	4,553	220,544	13,622	101,737	5,720	29,498	8,411	39,722
March 2	4,726	4,779	229,430	13,871	104,462	5,888	25,148	8,634	38,441
March 30	4,425	4,684	224,994	13,896	104,715	5,337	28,240	8,738	37,746
April 27	4,672	4,685	224,443	14,228	99,631	5,568	30,466	9,204	39,404
May 25	4,759	4,857	222,214	14,322	95,769	5,463	32,973	8,908	43,368
June 29	4,957	4,854	223,883	14,500	92,333	5,325	37,762	8,828	46,447
July 27	4,926	4,896	223,756	14,535	88,626	5,817	44,316	8,217	49,517
August 24	4,836	4,866	225,672	14,639	86,251	5,649	51,405	8,126	52,061
September 28	4,778	4,829	221,903	14,538	85,554	5,450	57,903	8,158	56,914
October 26	4,730	4,758	221,184	14,863	86,423	5,710	65,499	7,728	60,872
November 30	4,795	4,707	225,119	15,145	88,371	5,228	66,062	7,672	58,647
December 28	4,713	4,968	226,111	15,604	93,126	5,931	58,941	8,181	53,427
1947:									
January 25	4,672	4,820	221,655	14,624	99,801	5,630	50,357	8,224	48,558

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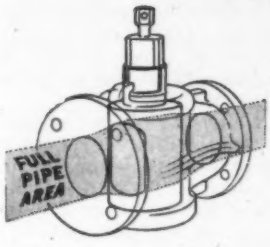

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THE MONTH...

are produced. The recovery and treatment of the hydrocarbon products for market would be accomplished by conventional refinery methods. Consideration is being given to the installation of a pipe line to transport finished gasoline and distillate fuels to markets in Kansas. The synthesis reaction itself is carried on under pressure in large 'fluid' type reactors utilizing a special powdered-iron catalyst. A large amount of heat is liberated in both the combustion and synthesis reactions, which is used to make sufficient high-pressure steam to provide practically all of the process requirements.

"One step of the Synthol process is based on the 'Fischer-Tropsch' synthesis principle, whereby a gaseous mixture of carbon monoxide and hydrogen is passed over a catalyst under suitable conditions of temperature and pressure to yield hydrocarbons in the liquid fuel range. The process, as applied industrially by the Germans, utilized coal as the raw material for preparing carbon monoxide and hydrogen, which were thereafter synthesized to hydrocarbon and chemical products.

"American engineers recognized the potentialities of the process and concluded that by the application of modern engineering it might be possible to reduce costs to a point where oil could be produced competitively with natural petroleum. Stanolind Oil & Gas Company has been one of the leaders in the United States in conducting research on improvement of the process. Studies have been carried forward for several years in laboratories at Tulsa, and synthetic gasoline has been produced on a pilot-plant scale. Particularly by application of the American fluid-catalyst technique, plant investment costs have been markedly reduced and yields of high-octane gasoline have been stepped up. In this country, dry natural gas is the cheapest source of synthesis feed stock, and recent developments favor the use of relatively pure oxygen for conversion of the natural gas to carbon monoxide and hydrogen.

"From the viewpoint of our national economy, the commercial development of the Synthol process is significant. Total natural gas reserves in the United States have been estimated at 175 trillion cubic feet. If all this gas were processed, some 12-15 billion barrels of oil could be made available to supplement our 21 billion barrels of known petroleum reserves. Furthermore, changes in economic conditions and improvements in the process may well make the conversion of coal into hydrocarbon liquid fuels attractive. Sufficient liquid fuel could be made in this manner to supply the country's needs for more than 1000 years at the present rate of consumption."

Stanolind to Build Gasoline Plant in Elk Basin Field

Permission has been granted Stanolind Oil & Gas Company, Unit Operator for the Elk Basin field, Wyoming, by the Civilian Production Administration for preliminary construction of buildings to house gasoline plant and repressure system. Construction is expected to be completed within two years. The plant would

YOU CAN'T AFFORD TO LOOK AT HEAT EXCHANGE EQUIPMENT

Through ROSE *colored glasses*

The very simplicity of the theory of transferring heat from one fluid to another without physical contact merely serves to underscore the numerous difficulties which must be overcome in its practical application.

Some of the heat exchange equipment produced by Kellogg involved super-pressures of from 5000 pounds per square inch and temperatures of 1100°F to high vacuum service and below zero temperatures of the order of liquid oxygen. Types of exchangers included gas to gas, gas to liquid and liquid to liquid, vapor condensers and waste heat boilers.

Over 4300 heat exchange units were produced by Kellogg during the war years.

Many novel and advanced techniques were developed by Kellogg during this period, the benefit of which are now available to refiners.

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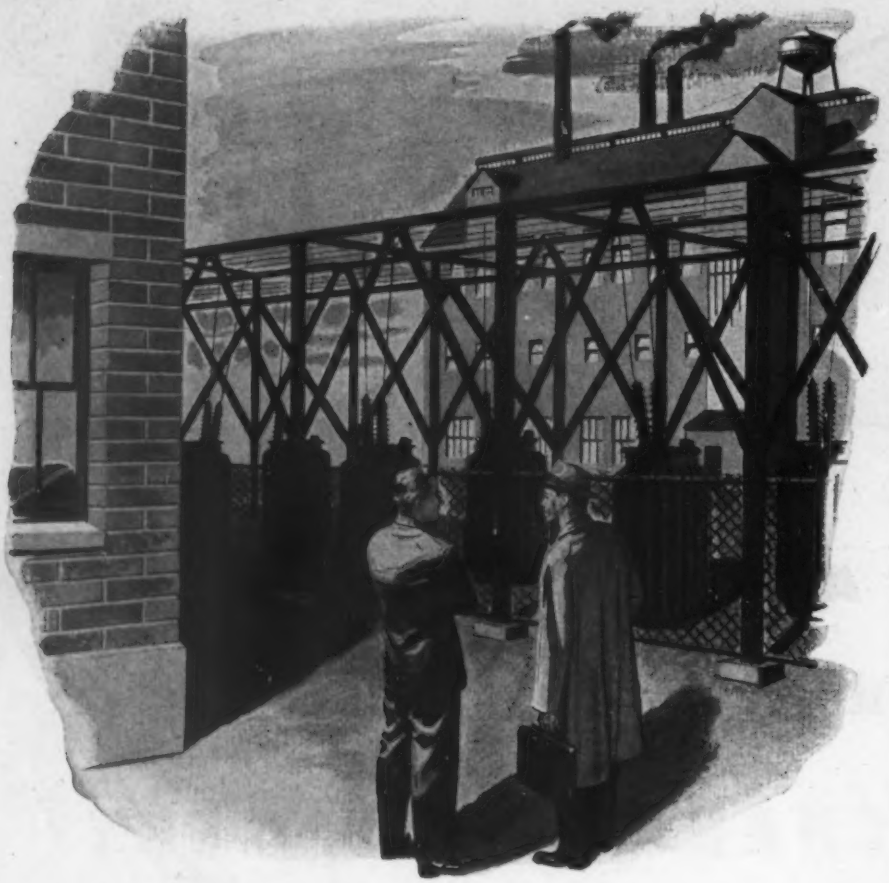

"For outdoor fire hazards like this, a wheeled extinguisher is a must!"

Inside your plant, but *outside* its building walls, there may be a fire-danger spot that's beyond the range of your present extinguishing equipment. Outdoor transformers, for example. Or flammable liquid storage tanks.

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And while you're talking to the Kidde representative, discuss your special indoor hazards with him too. His fire protection knowledge may be helpful to you in many ways — and it's always at your disposal.

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FIRE PROTECTION HEADQUARTERS

THE MONTH . . .

process 12 million cubic feet of gas per day and the repressure system is expected to handle 14 million cubic feet of inert gas per day.

Monsanto Chemical Organizes Texas Division

Monsanto Chemical Company has formed a Texas Division, which will operate a polystyrene plastics plant at Texas City, division headquarters. The present styrene plant, recently bought from the government, is the nucleus around which the plastics activity will be expanded. The styrene unit was operated during the war as a source of ingredient for chemical rubber.

The polystyrene unit to produce plastic molding powder is being installed in the buildings formerly owned by Texas Sugar Refining Company, which were bought by Monsanto five years ago, after being idle since 1933.

Joseph R. Mares has been named general manager of the new manufacturing unit. He has been director of the company's development department at St. Louis headquarters since 1943 and has been with the organization since 1929. H. K. Eckert is manager of the Monsanto plant at Texas City, where another 75 persons will be added to the plastics unit along with 500 now employed in styrene manufacture.

Mississippi Asphalt Plant Changes Ownership

Southland Oils, Inc., newly organized affiliate of Paluxy Asphalt Company, Dallas, has purchased Mississippi Asphalt & Refining Company's 3500-barrel daily capacity asphalt refinery at Sandersville, Mississippi, from Rogers Lacy and associates. Spokesmen for the new owner stated that the plant will be idle for 40 to 60 days while equipment is altered to process crude to be obtained from the near-by Heidelberg and Eucutta fields. A. A. Spencer is president of Southland Oils, Ltd., while Eugene Constantin, Jr. and W. H. Rogers, Jr., both of Dallas, are vice president and treasurer, respectively. Charles Else is secretary and H. H. Clardy is general plant superintendent for both companies.

Sid Richardson Takes Over Southport Lines and Plant

Sid W. Richardson, Fort Worth, has purchased Southport Petroleum Company's 20,000-barrel refinery at Texas City, Texas, from Clint W. Murchison and associates for a reported consideration of more than $2,000,000. The refinery, which will concentrate on markets reached by barge and tanker deliveries, will have Freeman W. Burford as manager.

Richardson, a large producer of oil in West Texas and the Texas-Louisiana and Mississippi Gulf Coast region, will have a substantial portion of this controlled oil available for the plant, or for exchange for more accessible crudes, while existing crude purchase contracts held by Southport also will be available. The refinery has direct pipe-line connec-

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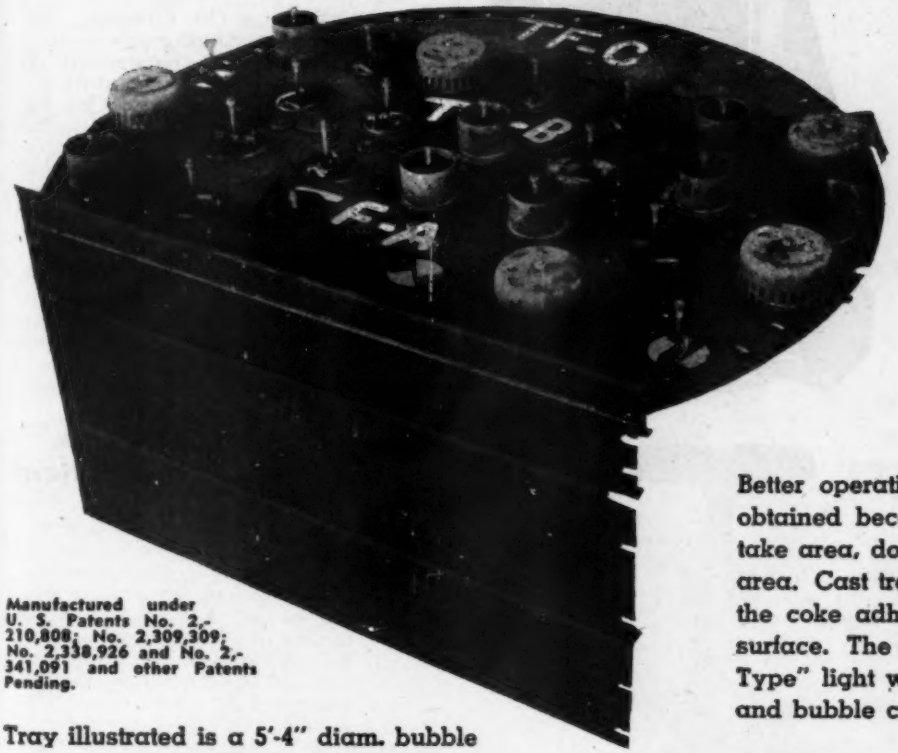
COKING PROBLEMS ARE MINIMIZED WHEN YOU USE *Glitsch* "TRUSS-TYPE" ALLOY BUBBLE TRAYS AND BUBBLE CAPS



Manufactured under U. S. Patents No. 2,210,808; No. 2,309,309; No. 2,338,926 and No. 2,341,091 and other Patents Pending.

Tray illustrated is a 5'-4" diam. bubble tray made of 12% chrome, type 410 stainless steel with straight downcomer. Note the "set-on" type risers and holddown frogs. These frogs, installed from the top of deck and snapped in the riser openings, eliminate the need for a man under the deck when installing or removing caps and risers.

WHY? Because in usual operation coke has very little affinity for GLITSCH alloy trays and caps.

Better operation and more uniform products are obtained because there is no loss in vapor uptake area, downcomer area or available cap slot area. Cast trays and caps tend to coke up since the coke adheres readily to the roughened cast surface. The smooth surface of GLITSCH "Truss-Type" light weight fabricated alloy bubble trays and bubble caps has minimized this problem.

Any accumulation of sludgy sediment that might tend to collect is easily removed with a hose. GLITSCH light weight trays and caps are removable — with a minimum of manpower — and it isn't necessary to disturb the supporting trusses. (And it's much safer for the men to handle the light weight trays)

MANUFACTURED UNDER U. S. PATENT NO. 2,210,808; NO. 2,309,309; NO. 2,338,926; NO. 2,341,091 AND OTHER PATENTS PENDING

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Here's all you need...

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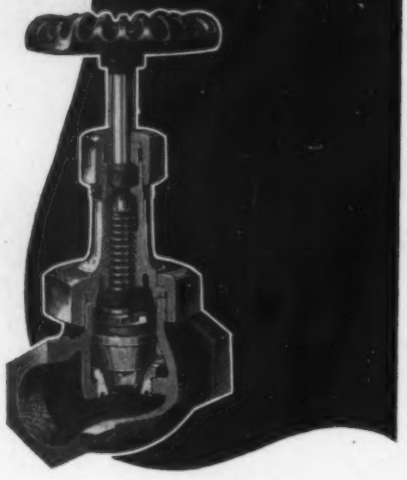
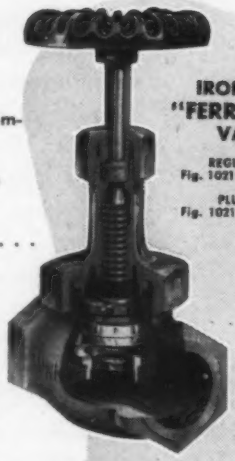
SEATS AND DISCS INTERCHANGEABLE ★



Just insert a plug type seat and disc in place of the regular type, and you change an *entire* Bronze "Renewo" Valve from regular to plug type—providing all the extra advantages of this type, including its ability to stand up under hard service. No other change is necessary. The plug type seat-and-disc combination is made to *fit perfectly* into a regular type valve of corresponding size and pattern. And you have this same interchangeability in Iron Body "Ferrenewo" Valves. You don't have to buy an entire new valve . . . you don't even have to take the valve out of the line. *Lunkenheimer interchangeability goes still farther. *All parts* of 200 lb. "Renewo" and 150 lb. "Ferrenewo" Valves (except bodies and bonnet rings) are quickly, easily, perfectly interchangeable. Fewer parts are needed; ordering and handling are simplified; repairs are facilitated. You save time, labor, money.

Write for a copy of Circular 567—



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THE MONTH...

tion to nearby coastal fields, and several major trunk lines are connected to the plant's tank farm.

A 13,000-barrel daily capacity Houdry unit built by the government for Southport to operate during the war is scheduled to be sold by WAA in February.

To operate as Sid Richardson Refining Company, the new owners, proposes to erect a 15,000-barrel lubricating oil unit to process oil produced by Richardson in the Keystone field in West Texas.

Freeman W. Burford is president of Sid Richardson Refining Company, Perry R. Bass, vice president, and Guy W. Mosley, secretary-treasurer. Headquarters are to be at the refinery.

Socony-Vacuum Makes Educational Grants

Socony-Vacuum Oil Company, Inc., has announced establishment of educational grants to enable outstanding employes in its research laboratories to study for advanced degrees. One candidate, selected each year from the laboratories, located in Brooklyn, New York, Paulsboro, New Jersey, and Dallas, Texas, will be granted a leave of absence, with full pay, for a period not exceeding three years. The first employe will be selected this summer.

Candidates must have a bachelor's degree and must be employed by the company for at least two years. Successful candidates, it is understood, will return to the employ of the company for at last two years after receiving degrees.

Bureau Reports Progress In Synthetics Investigations

Oil shale reserves in the United States are proving richer than estimated and new methods and equipment for converting them into oil give promise of eventual development of a process which will bring the cost of synthetic gasoline closer to that of the refinery product.

The Bureau of Mines program for development of commercial methods of producing synthetic fuels from shale, coal and other materials has made considerable progress. Currently it is estimated that gasoline can be produced from oil shale or coal at a cost of 7.5 to 9.5 cents a gallon, but without including profit or interest on investment.

That the shale resources of the country give promise of supplying more than the original estimate of 92 billion barrels of oil, is revealed by core drilling in western Colorado which indicate that 15 billion barrels of oil may be recovered from Naval Oil Shale Reserve No. 1 alone, an area of 44,560 acres. Two other reserves in that state comprise another 128,944 acres.

By the end of 1946, construction of three of the four major installations planned by the bureau had been completed, and contracts let for the fourth, which may go into operation early in 1948.

Laboratory and pilot-plant studies at Laramie, Wyoming, developed a process, which employs hot solvents to extract oil from the shale, which gave oil recoveries greater than the assay value of the shale, and thermal cracking studies on shale-oil fractions are nearing completion and investigation of catalytic

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● These are important advantages you enjoy when you make REPUBLIC your warehouse for refinery supplies. For everything best in refinery supplies and service you can depend on REPUBLIC. . . .

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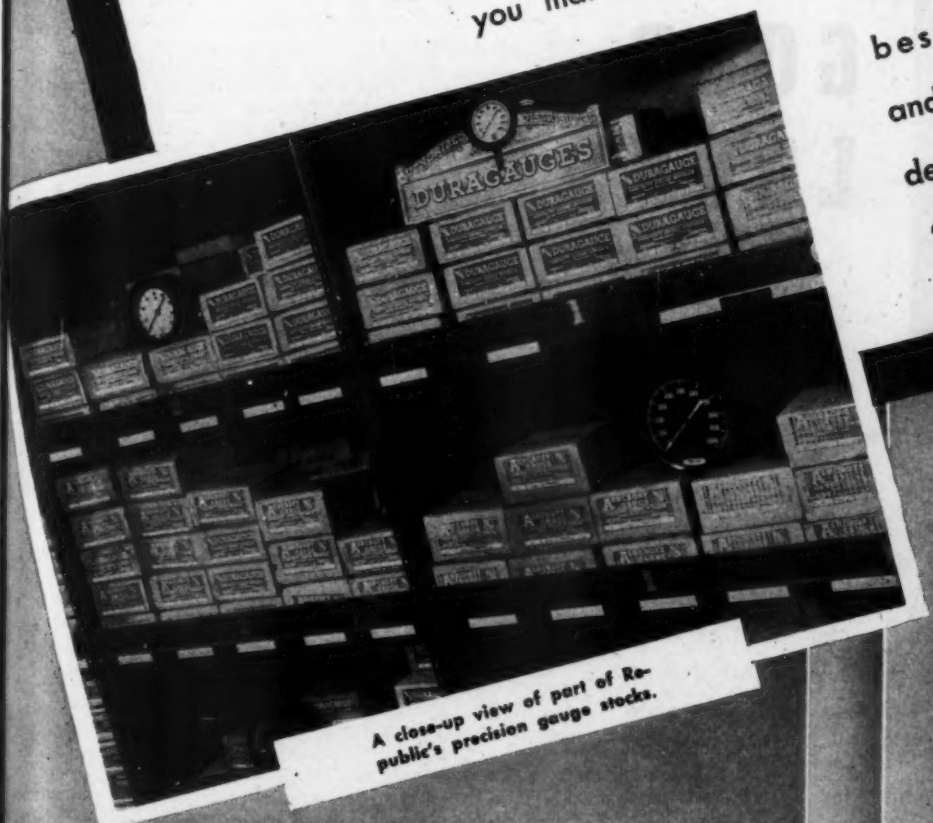

A close-up view of part of Republic's precision gauge stocks.

Republic Supply COMPANY

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REPUBLIC STEEL

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THE MONTH . . .

treating methods is under way. Researchers also are studying the by-product potentialities of oil shale.

At Rifle, Colorado, the oil-shale demonstration plant soon will be put into operation, and the bureau will test out its newly developed equipment and methods under conditions simulating those which would exist in industrial operation. Similarly, it will make a commercial-scale test of shale mining methods, and a mine is being opened in which the shale will be quarried with electric shovels and diesel trucks operating underground. This method may reduce mining costs to approximately 50 cents a ton.

Marked progress also has been made in the synthesis of coal, and in the hydrogenation process lower pressures and lighter equipment have been indicated as contributing importantly to reduction of production cost. Through use of a new type of reaction chamber embodying improved cooling methods, production rates more than double those of European plants have been attained. In Alabama, practicability of producing gas by burning coal in the ground is being tested, this along lines developed in Russia.

Commenting on the progress of the program in the annual report of Secretary of the Interior J. A. Krug, Dr. R. R. Sayers, director of the bureau, predicted that production of synthetic petroleum products on a commercial basis is possible within a few years.

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You can see the newly painted surface . . . the way it glistens and gleams. What you can't see is the care used in the surface preparation . . . and that is the real secret of long-time protection. To get it you must depend upon the integrity of those employed to do the job.

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American Mineral Spirits Expands to West Coast

American Mineral Spirits Company, Western, with home offices at 555 South Flower Street, Los Angeles 13, has been organized and is owned jointly by American Mineral Spirits Company and Richfield Oil Corporation.

American Mineral Spirits Company specializes in manufacture and marketing of petroleum solvents or technical naphthas.

All products marketed by the new Western will be made in the refinery of Richfield Oil Corporation at Watson, California.

Max A. Williams, vice president of American Mineral Spirits Company, and long identified with the petroleum solvent industry, is president of American Mineral Spirits Company, Western. David E. Day, vice president in charge of manufacturing for Richfield Oil Corporation, is executive vice president, and A. J. Falkenberg, formerly of American Mineral Spirits Company's Chicago office is secretary and treasurer.

Anglo-American Forms Research Organization

A petroleum research and development organization, to be known as Esso Development Company, has been formed by Anglo-American Oil Company for the purpose of working "in close collaboration" with officials and private organizations.

Esso Development, registered in England, also will coordinate its work with that of the existing research organizations of Standard Oil Company (New Jersey).

Directors of Esso Development include: D. A. Shepard, chairman of Anglo-American; R. A. Carder, managing director of Anglo-American; Brian Mead, refining coordinator for European companies of the Standard group, and R. C. Tett, managing director of the new company.

Otto Peters Honored For First-Aid Work

Otto Peters, veteran purchasing agent of Cosden Petroleum Corporation, Big Spring Texas, recently was presented with a gold watch by his company in recognition of his service to the company and the community. In the presentation of the award by his associates within the company it was noted that his first-aid work probably has contributed to the saving of several lives in various plant mishaps over the past 15 years. Coincidentally, Peters has just graduated another class of 20 Cosden first aiders.

Somewhat earlier Peters was guest at a banquet given by the local Red Cross chapter in his honor, and was presented with a medal in appreciation of his efforts in training several hundred first-aid students in his community during the last few years.

Danciger Plant and Lines Bought by Phillips

Phillips Petroleum Company has bought a part of the equipment of the 6000-barrel refining plant of Danciger Oil & Refineries, along with pipe-line facilities for gathering both crude oil and natural gas. The absorption natural gasoline plant was retained by the Danciger company for removal to another location.

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applies in the storage tank business, too!

The FOLLOW THROUGH we mean starts after the order is placed—after the engineering is completed and accepted—after the steel has been fabricated . . .

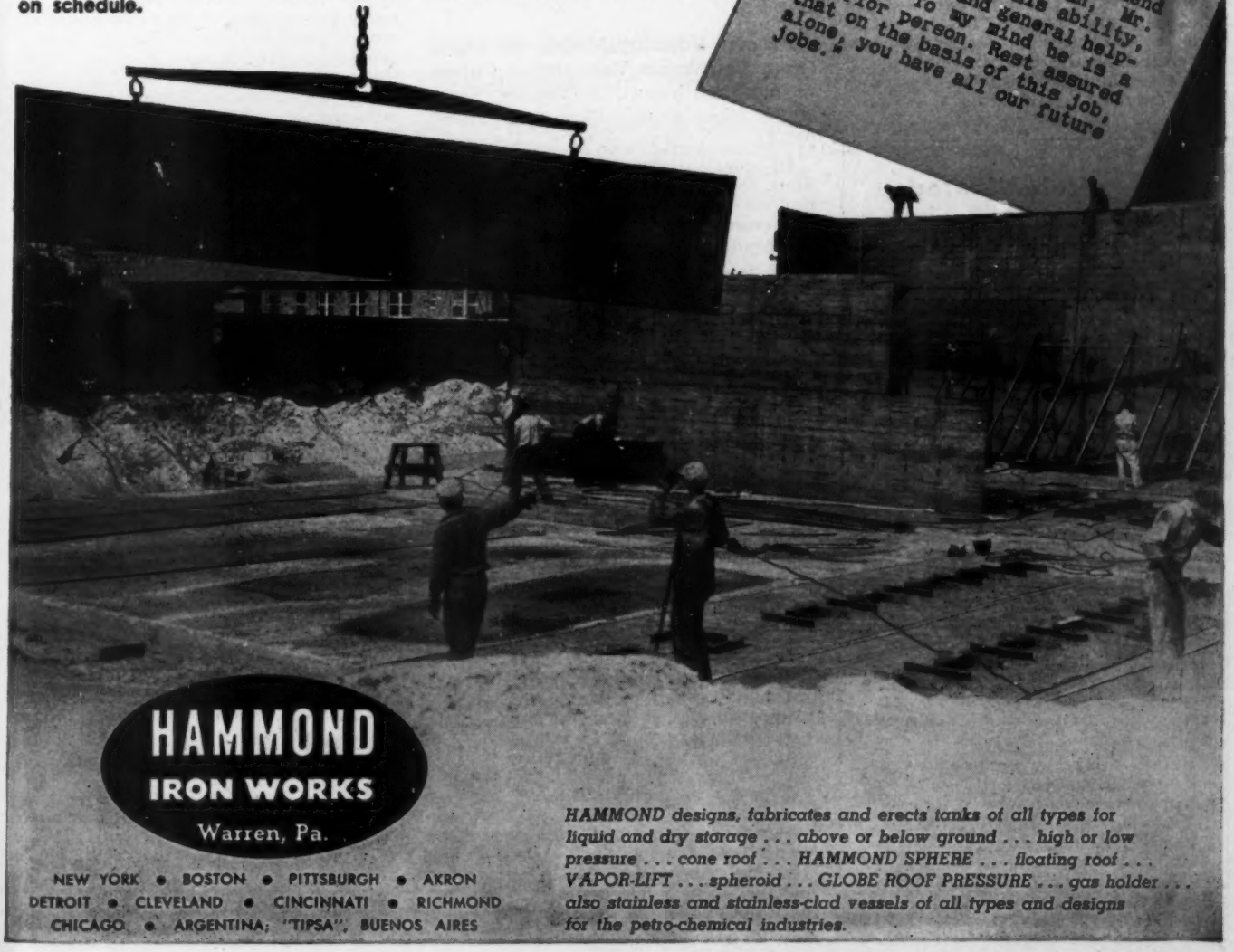
the ***Follow Through*** we mean starts when construction begins . . . the ***Follow Through*** of the engineer, foreman and erection crews; their abilities, their cooperation, their attitude of helpfulness and understanding of the importance for an efficient job . . . that's what we at ***Hammond*** mean by ***Follow Through.***

How well Hammond erection crews and engineers FOLLOW THROUGH is best told by two buyers of "HAMONDTANKS" . . . quotations from their letters are reproduced here . . . these comments were unsolicited and of course the names of the writers may be had on request.

You can depend upon HAMMOND for the FOLLOW THROUGH which means storage tanks, soundly built and ready for service on schedule.

". . . we cannot overlook the efficiency of your erection crews and the speed in which our 100,000 gallon tank was erected. Under present conditions it is not uncommon to receive letters of complaint regarding delivery, etc., and for that reason we know you will be interested in knowing of this fine installation and the efficiency of your field crews."

". . . my purpose in writing you is to offer my thanks for what I consider a very satisfactory job, performed by an efficient organization. I think this is unusual especially as my only contact with you folks has been by mail and telephone. At this time I would like to commend your erection foreman, Mr. ..... upon his ability, co-operation and general helpfulness. To my mind he is a superior person. Rest assured that on the basis of this job, alone, you have all our future jobs."



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SCIENCE AND TECHNOLOGY ABSTRACTS

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The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Thermodynamic Properties of Saturated Propylene, Propane, Isobutane, Isobutylene and Normal Butane. GEORGE H. HANSON, *Trans. Amer. Inst. Chem. Eng.* **42** (1946) 959-73.

The thermodynamic properties of saturated propylene, propane, isobutane, isobutylene and normal butane have been correlated and are presented in five tables. Temperature, vapor pressure, specific volume, density, enthalpy, latent heat and entropy are tabulated. The ranges of temperature covered by the tables are: propylene, —100 to 196.5° F.; propane, —75 to 206.3° F.; isobutane, —20 to 274.6° F.; isobutylene, —20 to 292.5° F.; and normal butane, 0 to 305.6° F. In each instance the highest temperature is the critical temperature. The thermodynamic properties are given at five-degree (F.) intervals.

Vapor Pressures of Twelve Four-carbon-atom Hydrocarbons. KARL HACHMUTH, GEORGE H. HANSON, AND MARY LAVINA SMITH, *Trans. Amer. Inst. Chem. Eng.* **42** (1946) 975-88.

A correlation of the vapor pressures data for 12 four-carbon-atom hydrocarbons was made. The correlated values are presented in tabular form and also as a vapor-pressure chart. The hydrocarbons recovered in the work are isobutane, iso-butylene, 1-butene, 1,3-butadiene, n-butane, trans-2-butene, cis-2-butene, vinylacetylene, ethylacetylene, diacetylene, 1,2-butadiene and dimethylacetylene.

Relative Volatility Method for Calculating Equilibrium-Vaporization Curves. D. A. SMITH AND G. W. WILSON, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 927-37.

In order to minimize the trial calculations required in equilibrium vaporization problems, a new and more rapidly converging equation has been developed, by means of which flash curves can be calculated in approximately half the time normally required when using the conventional procedure. The new method takes advantage of the fact that over small temperature intervals the ratio of the equilibrium constants for any two components is essentially constant. The proposed method is applied to two specific problems.

Pilot Pipe-line Unit for Determining Viscosity-Temperature Relationships. R. B. BECKMANN, H. G. CORNEIL, AND R. J. MICHAEL, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 947-58.

Reliable viscosity data for waxy crude oils at the lower pipe-line operating temperatures cannot be obtained with conventional laboratory viscometers, because the crystals of wax present in the crude cause irregular flow in tube- or orifice-type instruments. Also, the vaporization of components from high-vapor-pressure crudes interferes with the measurements. The authors constructed an apparatus of special design and operated it to obtain reliable viscosity data for waxy crude oils. The equipment used is a pilot-scale pipe-line unit and requires an oil charge of approximately 20 gallons for operation.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal, and Dearborn Streets, Chicago 16, Illinois, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

1,18-Octadecandioic acid
Δ^3-Cyclopentenylchloride
β-(Δ^3-Cyclopentenyl) ethyl chloride
Quinuclidine
3-Pyridine aldehyde
o,p'-Dihydroxydiphenyl
o,p-Dihydroxydiphenyl
2,3-Dimethyl benzaldehyde
2,3,4-Trimethylbenzaldehyde
Divinyl sulfide
Divinyl disulfide
p-Benzylphenol
Methyl octanes
Dimethyl heptanes
Dimethylethylpentanes
Dimethylcyclohexanes
Trimethylcyclopentanes
Methylethylcyclopentanes
Propyl cyclopentane
Isopropylcyclopentane
Methylethylcyclohexanes
Propylcyclohexane
Isopropylcyclohexane
Tetramethylcyclopentane
Dimethylethylcyclopentanes

Chemical Compositions and Reactions

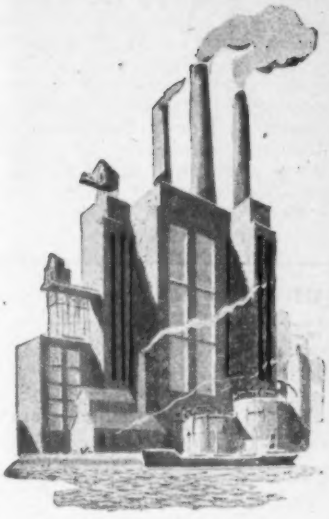
Peroxidation in Relation to Olefinic Structure. E. H. FARMER, *Trans. Faraday Soc.* **42** (1946) 228-36.

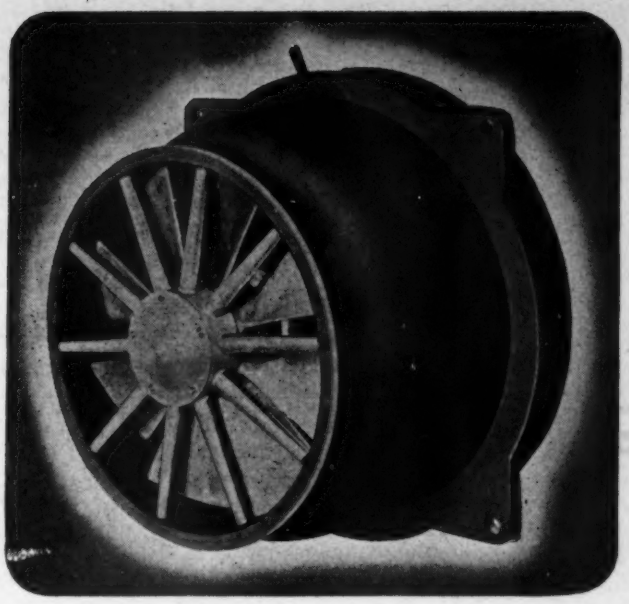
The autooxidation of olefinic substances involves two major phenomena, peroxidation and peroxide decomposition. The paper surveys the structure and the breakdown behavior of the various types of organic peroxides. All peroxides of non-aromatic conjugated dienes and polyenes are produced by the addition of oxygen at the terminal of the diene systems. All of these peroxides are polymeric substances and show high thermal stability. The crude polymeric peroxides from open-chained conjugated substances usually contain oxidative scission products formed during the absorption of oxygen or in the presence of catalysts during attempted catalytic hydrogenation of the peroxides.

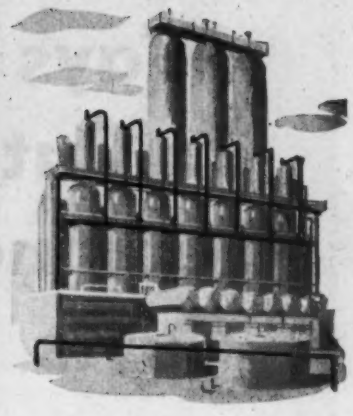
The di- and poly-olefinic substances containing 1:4 systems of bonds are extensively rearranged into conjugated forms during peroxidation. Mono-olefinic systems autooxidize less readily, but behave in a similar manner to produce hydroperoxides in which the OOH groups are attached to alpha-methylenic carbon atoms. The hydroperoxidation of olefinic systems proceeds readily in non-ionizing media and follows a radical-actuated chain mechanism. The tendency of the conjugated olefins to polymerize does not disappear entirely in the case of mono-olefins. In most hydroperoxide formation there is an appreciable polymer fraction formed. Various finely divided metals and metallic derivatives and salts actively promote peroxide decomposition, which is characterized by the formation of carbonyl groups in place of tertiary hydroxyl groups.

Determination of the Kinetics Mechanism of a Catalytic Reaction. JOHN L. TSCHERNITZ, SIDNEY BORNSTEIN, R. B. BECKMANN, AND O. A. HOUGEN, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 883-905.

The reaction studied was the vapor-phase hydrogenation of mixed isooctenes (commonly called codimer) in the presence of a solid supported nickel catalyst. This reaction is relatively easy to control and progresses without successive side reactions. The object of the







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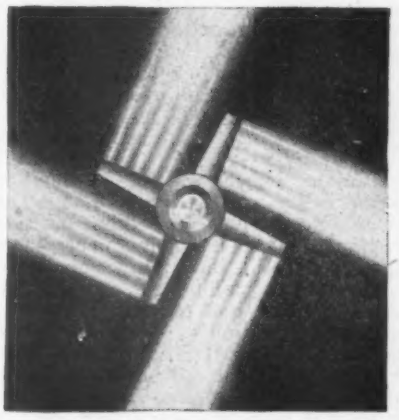

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work was to develop a method for determining the predominating reaction mechanism for a reaction catalyzed by a solid surface and for which many mechanisms may be postulated. The authors considered 17 possible chemical steps in the reaction and the independent and ever-present steps of diffusion of reactants to the catalyst surface and of product away from the surface. It was considered well established that for the reaction studied the mechanism comprised a surface reaction between the activatedly adsorbed hydrogen and codimer to form activatedly adsorbed hydrogenated codimer. An equation is given for the expression of the reaction rate. For the given conditions of pressure and composition the reaction rate increases with rise in temperature to a maximum value and then decreases with further rise in temperature. This is explained by the opposing effects of temperature upon the surface velocity constants and the equilibrium adsorption constants. The data are presented in detail in 7 tables, and a bibliography of 10 references is included.

Manufacture: Processes and Plant

Synthetic Liquid Motor Fuel From Farm Residues. *Chemical Engineering* **53** (1946) 104-5.

At Peoria, Illinois, the Department of Agriculture has a semi-works plant built to show the maximum yields of alcohol, butanol and acetone, or isopropyl alcohol that can be made from a given tonnage of various farm residues. The scale of operation is large enough to provide a basis for computing costs and determining the feasibility of commercial production. The plant is designed to produce 500 gallons of alcohol per day and it is the bureau's contribution to the research program, authorized by Congress in 1944, for the building of demonstration plants to produce liquid motor fuels from non-petroleum sources. If experimental results are verified in the plant, there will be obtained 90 to 95 gallons of motor fuel from each ton of residue, about half of which will be in the form of ethyl alcohol. From the farm waste materials, the plant will produce at capacity 2000 pounds of glucose in 10-percent solution, 1600 pounds of xylose in 15-percent solution, 200 pounds of furfural, and 1000 pounds of liquid in an 8-hour day. A flow sheet of the plant is presented as well as cuts showing various items of the equipment used.

Synthetic Fuels Promise to Bolster Petroleum Reserves. P. C. KEITH, *Chemical Engineering*, **53** (1946) pp. 101-103.

The author is of the opinion that large scale production of synthetic motor fuel, not only from natural gas, but from coal as well, will soon be under way in this country. The equivalence of the three basic fuels, coal, oil and natural gas, is to be considered and is in a sense a new concept, for it implies that in a fuel problem one can simply consider energy, rather than fuel as such. The development of synthetic fuels from the first work of Bergius in 1910 is briefly traced. Two plants to use the low-pressure synthesis are under construction in this country, and it has been predicted that the cost of gasoline will be 5¼ cents per gallon. Two war techniques have contributed greatly, namely the use of the fluid bed and the production of cheap oxygen. The direct transportation of coal is reviewed, starting with a discussion of the Lurgi Company's plant in Germany and the most recent Lurgi installations in Czechoslovakia. At this latter plant gas of 570 Btu per cubic foot is being produced at an efficiency in the gasification step in excess of the 80 percent. This plant supplies gas at 300 pounds pressure to a 120-mile distribution system. The author sees no reason why coking coals, such as those of this country, cannot be gasified to yield a gas of 900 to 950 Btu per cubic foot with a thermal efficiency of 80 percent. Other factors in fuel utilization, such as transportation costs and fuel efficiency, are considered.

Plate Efficiencies of Benzene-Toluene-Xylene Systems in Distillation. MELVIN NORD, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 863-81.

The effect on plate efficiency of adding a third component to a two-component system is not well understood and few data are available. The author presents experimental data on plate efficiency for the systems benzene-toluene, benzene-*m*-xylene, toluene-*m*-xylene, benzene-toluene-*m*-xylene to illustrate the effect of adding a third component to a two-component system. Considerable range of concentration was studied and thus data were secured on the effect of concentration on plate efficiency. The column used in the work is described. The results obtained indicate that there is a maximum plate efficiency for each component at about 60 percent of the light component. A similar result was found for ternary systems, in which the maximum efficiency was had at about 60 percent benzene, 20 percent toluene, and 20 percent *m*-xylene. Maximum efficiencies for each of the components were about 70 percent, but at low concentrations of any component, efficiencies ranged from 28 to 46 percent. There was a definite gradation in efficiency as the concentration departed appreciably from 60 percent benzene, 20 percent toluene, and 20 percent *m*-xylene. The reason for variation in plate efficiency with concentration is not known.

Fractional Distillation of Ternary Mixtures. Part II. A. J. V. UNDERWOOD, *Jour. Inst. of Petroleum*, **32** (1946) 598-613.

In the first part of the paper previously published equations are presented for computing the composition on any plate in a fractionating column handling ternary mixtures. Basic equations previously derived now are employed to determine the conditions for a state of minimum reflux. Equations are given by which the minimum reflux ratio for ternary solutions can be calculated when the fractionation between the key components is sharp.

Calculation of Number of Theoretical Plates for Rectifying Columns. A. E. STOPPEL, *Ind. and Eng. Chem.* **38** (1946) pp. 1271-72.

If the equilibrium curve and the operating line of the typical McCabe-Thiele distillation diagram are extended beyond their usual limits, the operating

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line will be found to cut the equilibrium curve at two points, one of which is on the chart proper, and the other outside the chart. The author develops a method by which the number of theoretical plates required for the column can be expressed as a simple power function of these two points of intersection. The method outlined leads to an expression that is algebraically identical to the equation proposed by Smoker.

Application of Matrices and Finite Difference Equations to Binary Distillation. NEAL AMUNDSON, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 939-46.

The author presents a mathematical exposition of the solution of the McCabe-Thiele method for calculating the number of plates for the distillation of a binary system when the equilibrium diagram can be expressed in the form of a simple equation. The method proposed makes use of some elementary properties of square matrices and linear difference equations. The method as developed is applied to the solution of the problem of determining the number of plates in a column for the distillation of the system benzene-toluene.

Fractional Distillation of Multi-Component Mixtures — Calculation of Minimum Reflux Ratio. A. J. V. UNDERWOOD, *Jour. Inst. of Petroleum,* **32** (1946) 614-26.

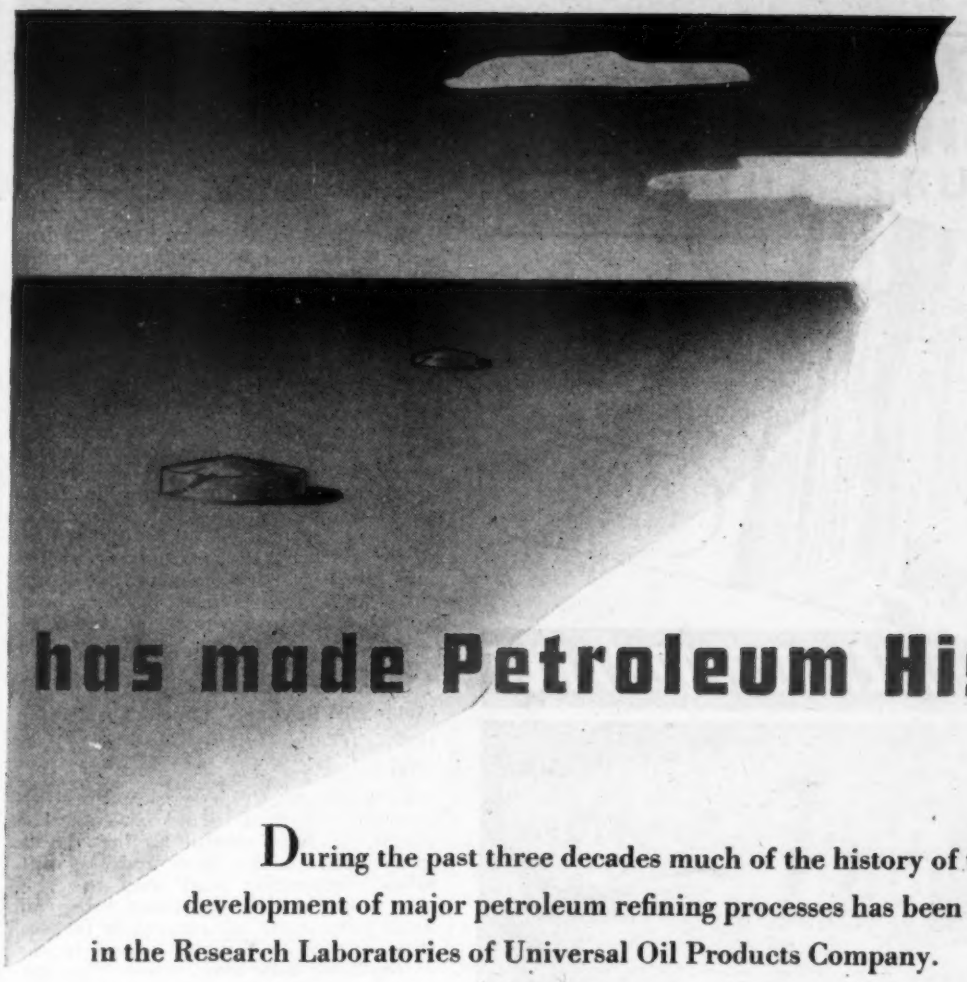
An extension of the method that the author has applied to ternary mixtures is given and equations are derived by means of which the minimum reflux ratio for multi-component solutions can be readily calculated when the fractionation between the key components is sharp and relative volatilities and molal reflux are assumed to be constant. Numerical examples are given to illustrate application of method of calculation.

Separation of Butadiene by Azeotropic Distillation with Ammonia. N. POFFENBERGER, L. H. HORSLEY, H. S. NUTTING, AND E. C. BRITTON, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 815-26.

The process and plant used to separate butadiene from butanes and butylenes by azeotropic distillation with ammonia is described. Data are given on azeotropic compositions and vapor-liquid equilibria, and also on the solubility phase diagrams of the systems butylene-ammonia and butylene-ammonia-water, upon which the processes used to recover ammonia were based. The distillation is unusual because the ammonia-hydrocarbon azeotropes under the plant operating pressure all have the same boiling point. Flow sheets of the plant used are presented, the equipment is described, and the operation of the plant is discussed. The principal difficulty obtained in plant operation was the formation of polymer, particularly in the bottom reboiler and in the bottom five trays of the main azeotrope column. The formation of the polymer was erratic and would require a cleanout at intervals varying from three to four weeks up to several months. Polymerization inhibitors were tried with no particular success.

Predicting Commercial Heat-Transfer Coefficients. E. P. BREIDENBACH AND H. E. O'CONNELL, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 761-76.

Eighty over-all heat-transfer coefficients were measured on 24 commercial



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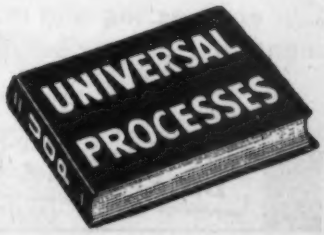

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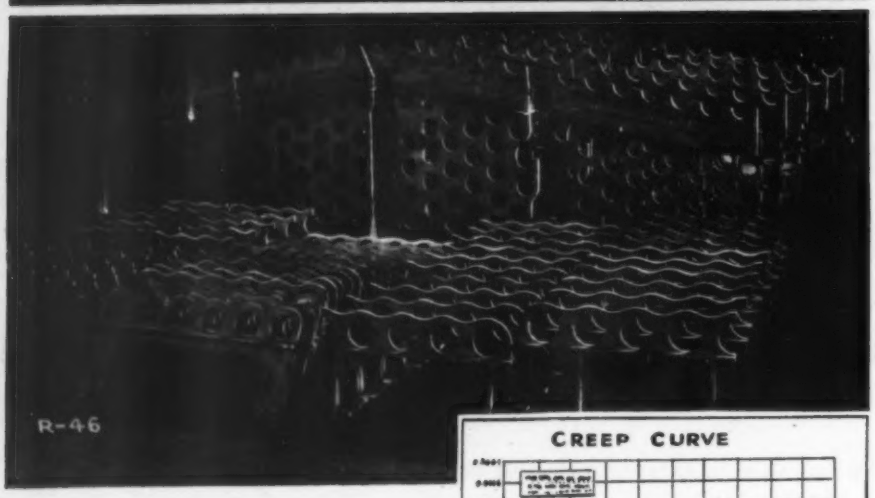

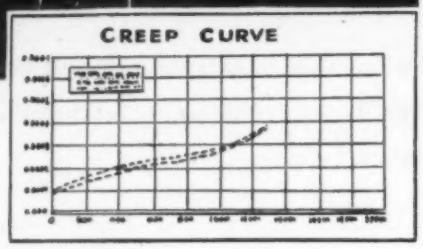

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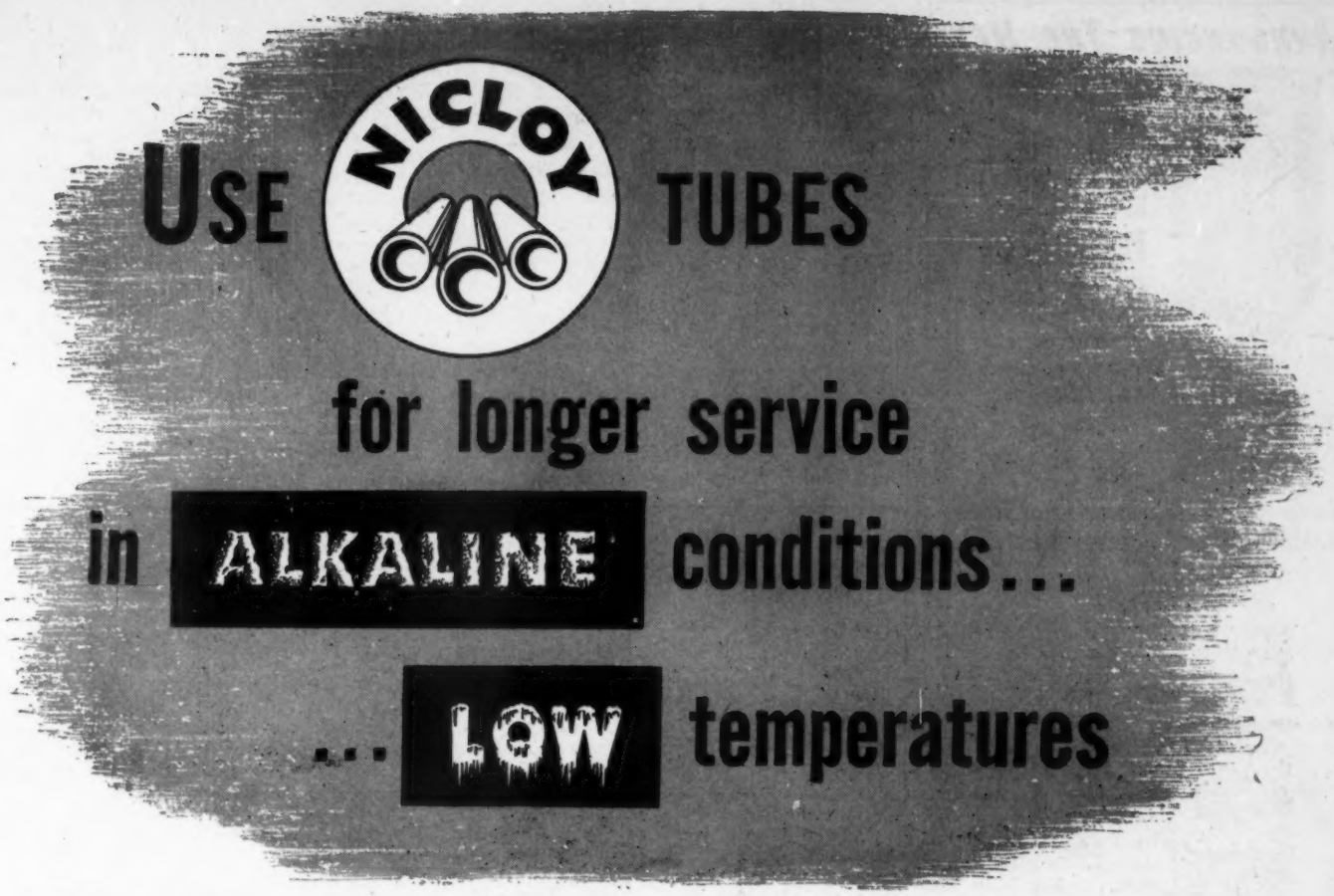
heat exchangers. Data are presented in tabular form and the actual coefficients compared with theoretical coefficients predicted from correlations available in the literature. The authors conclude that commercial heat-transfer coefficients can be calculated with engineering accuracy for condensers, liquid-liquid exchangers and gas exchangers when the devices are handling water, chlorinated hydrocarbons and low-boiling hydrocarbons. They believe that coefficients can be calculated for other systems if the fouling factor is known. For systems with a high fouling factor the coefficients cannot be predicted with accuracy because the fouling film may be the controlling film and is the most uncertain. The overall heat transfer coefficients for reboilers boiling liquid with condensing steam cannot be calculated, chiefly because the boiling film cannot be determined. However, for design purposes a heat flux density of 8000 to 10,000 Btu/hr./sq. ft/1° F., at a temperature difference of 80° F. gives conservative values for boiling low-boiling hydrocarbons, chlorinated hydrocarbons and water solutions.

Mean Temperature Difference in the Field or Bayonet Tube. NORMAN L. HURD, *Ind. and Eng. Chem.* **38** (1946) 1266-72.

In the bayonet type tube an inner tube conducts the fluid to the far end, from which the fluid returns to the annular space between the inner and the outer tubes, exchanging heat with the shell side fluid through the outer tube wall. Such tubes have advantages in freedom from expansion difficulties and in ease of replacing individual tubes. This type of tube is sometimes used to minimize shell-side friction losses, as for example, in vacuum condensers. A distinguishing feature from the standpoint of heat transfer is the interchange of heat between passes of the tube-side fluid. Heat is exchanged between the inner conducting wall and the annular space as well as between the latter and the shell-side fluid. In applications where the tube-side fluid undergoes no change in phase this interchange of heat cannot in general be neglected. The effect of the interchange is to lower the mean temperature difference between the shell-side and the tube-side fluid. The author derives equations and presents curves giving the mean temperature difference across the outside tube wall for the four possible arrangements of longitudinal fluid flow in the bayonet tubes. A concept of equivalent greater and lesser temperature differences is used, from which the true mean temperature difference can be obtained by taking the logarithmic mean. This concept is believed to have promise of general application to heat-transfer problems involving varying surface arrangements for mixed streams in combinations of cocurrent and countercurrent flow.

Power Consumption of Agitators. JOSEPH J. MARTIN, *Trans. Amer. Inst. Chem. Engrs.* **42** (1946) 777-81.

Power consumption curves for 13 different agitators are plotted on a single graph, using data obtained by seven different groups of investigators. A fundamental power equation for geometrically similar agitators rotating in geometrically similar tanks is presented and is used in a rewritten form. This equation is discussed and the application of the



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equation to non-geometrically similar systems is considered. A bibliography of eight references is included.

Equipment Costs and Other Items in Engineering Economics. J. HAPPEL, R. S. ARIES AND W. J. BORNS, *Chemical Engineering,* 53 (1946) pp. 97-100.

This is the second half of the authors' article discussing investment costs and the operating costs of equipment in process plants. Costs of various types of instruments are tabulated. 20-30 percent must be added to the actual cost of the instruments to take care of panel boards, air supply and other auxiliaries. Cost of installation requires another 3 to 5 percent. The costs of motors, transformers, and indoor and outdoor lighting fixtures are tabulated, including splash-proof and explosion-proof types. Electrical equipment costs range from 7 to 15 percent of the cost of the major process equipment. Field labor for installation of electrical equipment adds 150-200 percent based on the cost of the electrical materials. The cost of furnaces is given as dollars per 1000 Btu per hour. The costs of conical-roof tanks and spherical tanks are tabulated, expressed as cents per gallon of capacity. Typical cost figures are included for concrete, structural steel, insulation, fireproofing, painting, and simple buildings such as are used for pump and control houses. Items of indirect cost are briefly reviewed. The latter half of the article deals with the subject of operating costs and expenses, including raw materials costs, the costs of labor, utility costs and overhead expense, such as amortization of equipment. The economic evaluation of processes is briefly considered.

Products: Properties, Utilization and Analysis

The Tendency to Smoke of Organic Substances on Burning. Part I. A. E. CLARKE, T. G. HUNTER, AND F. H. GARNER, *Jour. Inst. of Petroleum* **32** (1946) 627-42.

The smoking tendency of a large number of organic compounds was determined by flame-height measurements in a special lamp based on the I.P. smoke lamp. A burning organic substance has a flame height at and above which smoking occurs, and this height is a measure of the tendency to smoke. A new form of lamp was developed to measure flame-height from about 9 to 450 mm., with liquid compounds burning freely in air. A wide range of hydrocarbons, alcohols, ketones, esters and nitro-compounds was examined—115 compounds in all. A compact molecule was found to give a smoky flame. The order for increasing the tendency to smoke for the hydrocarbons is: n-paraffins, naphthenes, olefines, and aromatics. In the case of the paraffins, increased chain length or chain branching increases the smoking tendency, and in the case of aromatic compounds, no marked reduction in smoking tendency is found when the compound contains aliphatic side chains.

Quantitative Analysis of Hydrocarbon Mixtures by Means of Raman Spectra. E. J. ROSENBAUS, C. C. MARTIN, AND J. L. LAUER, *Ind and Eng. Chem., Anal. Ed.,* **18** (1946) pp. 731-33.

The paper describes the authors' technique in applying Raman spectra to the analysis of certain hydrocarbon solutions and indicates the type of results obtained. In the method of Raman spectra, essentially monochromatic light is sent into the sample and the scattered light is examined for lines of modified wave length. The analysis of the sample is based on the position and intensity of these modified lines. The method developed by the authors was applied to the analysis of known four- and five-component samples, and to the analysis of a trimethyl pentane mixture.

Effect of Uniform versus Intermittent Product Withdrawal from Distillation Columns. D. M. OLDROYD AND L. A. GOLDBLATT, *Ind. & Eng. Chem., Anal. Ed.,* **18** (1946) pp. 761-63.

It has been generally assumed that the best way to operate high-efficiency distillation columns is to remove the product continuously. The authors studied the separation of alpha and beta pinene, using a heligrid-packed column, a column packed with helices, and a gauze-plate column. The relative effectiveness of intermittent versus continuous product withdrawal was studied. It was found that intermittent withdrawal was the better method, particularly in the case of the operation of the heligrid-packed column. For example, it was better to take the product off once every hour than once every 30 seconds, or continuously.

The Application of Spreading Measurements on Oil Tests. N. E. M. HAGETHORN AND F. H. STIELTJES, *Jour. Inst. of Petroleum,* **32** (1946) 587-97.

A method is described for testing the spreading value of oil. The value of measurements of the spreading value is considered and the possibility of putting this value into practice is discussed. The spreading measurements offer a particularly sensitive method for investigating the properties of mineral oils that are of importance from the standpoint of their oxidation stability and purity. Changes can be detected by this means when other methods fail.

Automatic Determination of Aniline Point of Petroleum Products. C. W. BROWN, *Ind. and Eng. Chem., Anal. Ed.,* **18** (1946) pp. 739-41.

The author describes an apparatus for the automatic determination of the aniline point of petroleum products. An electric eye is used as a substitute for visual observation. The sample is internally heated or cooled, and the temperature is maintained uniform by stirring. Temperature equilibrium is accomplished automatically by means of a relay system. This system is activated by directing a beam of light through the sample onto a photocell. The light beam is interrupted periodically as the sample clears or clouds with slight temperature change. Flashing of a lamp bulb indicates when equilibrium temperature is reached. The apparatus is described in some detail and photographs are presented. Typical results are given and compared with the results obtained by ASTM methods. The method can be applied to dark-colored petroleum products and typical results of such applications are given.

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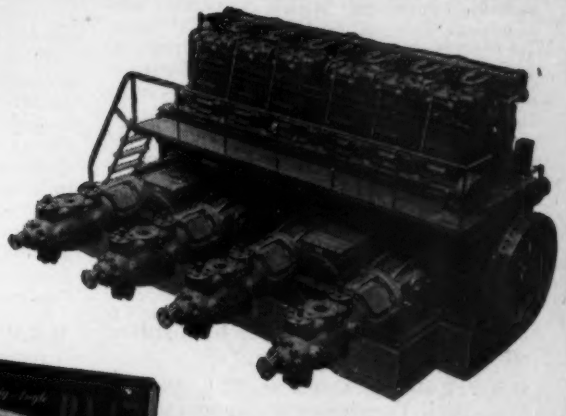

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Compiled by HEINZ HEINEMANN

REFINING

U.S.P. 2,410,829. Stabilization of Gasoline and of Addition Agents Therefor. D. B. Luten, Jr., to Shell Development Company.

The invention relates to a composition comprising hydrocarbons containing a knock-reducing amount of a mononuclear aromatic amine in which the total number of C atoms in all alkyl radicals is less than 7, and a stabilizing amount of a 2,4-dialkyl phenol in which one alkyl substituent is either a primary or a secondary or a tertiary alkyl radical while the other alkyl substituent is either a primary or a secondary alkyl radical. For example, the composition comprises 0.25-3 percent by volume of xylidine in addition to gasoline hydrocarbons, 0.001-0.1 percent by weight of a mixture of 2,4-dimethyl-6-tertiary butyl phenol and 2-tertiary butyl-4-methyl phenol, and up to 6 cc tetra ethyl lead per gallon of the composition.

U.S.P. 2,410,839. Production of Unsaturated Hydrocarbon Products. F. S. Rostler and H. I. du Pont to Wilmington Chemical Corporation.

Paraffinic hydrocarbons are separated from solvent extracts of petroleum and from vulcanizable unsaturated hydrocarbon products obtained from petroleum refining residues, which extracts and products have a boiling range at least as high as lubricating oils, by treating such a material with gasoline or heptane in combination with furfural. The mixture obtained is heated to a temperature at which all components are completely dissolved. The mixture is then cooled to a temperature at which stratification between the gasoline or heptane solution of the paraffins and the furfural solution of the vulcanizable unsaturated hydrocarbons takes place. The layers formed on settling are separated, and the unsaturated hydrocarbons are recovered from the bottom layer by distilling off the solvent.

U.S.P. 2,410,846. Gasoline. E. L. Walters to Shell Development Company.

The gasoline-type motor fuel according to this patent contains stabilizing amounts of 2,4-dimethyl-6-tertiary butyl phenol and a mononuclear aromatic amine in which the total number of C atoms in all alkyl radicals is less than 7. (Cf. U.S.P. 2,410,829). Aromatic amines employed include aniline, toluidine, and xylidine.

U.S.P. 2,410,847. Stabilization of Gasoline and of Addition Agents Therefor. E. L. Walters to Shell Development Company.

A composition similar to that of U.S.P. 2,410,829 is described in which the stabilizing component is a diortho-para polyalkyl phenol having a maximum of 18 C atoms and in which the para substituent consists either of hydrogen atoms, or methyl or ethyl radicals, one ortho radical being a primary, secondary or tertiary alkyl radical, and the other ortho radical being a primary or secondary alkyl radical. The stabilizing component, for example, may consist of 0.001-0.1 percent by weight of a mixture of 2,4-dimethyl-6-tertiary butyl phenol and 2,4,6-trimethyl phenol.

U.S.P. 2,411,083. Process for Treating Hydrocarbons. O. L. Davis and A. C. Nixon to Shell Development Company.

A hydrocarbon fraction is treated with an alkaline liquid, such as an aqueous copper ammonium acetate solution, in the presence of a relatively small amount of an organic amine having at least one alkyl radical of more than 4 C atoms and miscible with the alkaline liquid. The formation of a relatively stable dispersion is prevented by the addition of the organic amine.

U.S.P. 2,411,105. Process for Treating Hydrocarbons. A. C. Nixon and D. L. Yabroff to Shell Development Company.

This process has a purpose similar to that of U.S.P. 2,411,083, i.e., preventing the formation or reducing the stability of a dispersion caused by impurities in the treatment of a mixture of hydrocarbons with a copper ammonium acetate solution, or the like, for the purpose of forming two phases the one of which contains the components of the treated mixture soluble in the treating liquid and the other of which contains hydrocarbons insoluble therein. An organic surface-active agent, which forms a dispersion of colloidal dimensions in the aqueous treating liquid is used as the dispersion preventing or reducing agent in an amount of 0.001-1 percent by volume of the treating liquid. Salts of a naphthenic acid with a mol weight of 250-500, such as alkali salts of a petroleum naphthenic acid, are suitable surface-active agents.

U.S.P. 2.411,106. Separation of Styrene from Ethyl Benzene by Azeotropic Distillation. T. A. Petry and G. L. Payne to Socony-Vacuum Oil Company.

Crude mixtures comprising styrene and contaminants of similar boiling point, primarily ethyl benzene, are distilled in the presence of glycol monoethyl ether as a distillation assistant. At least two fractions are recovered the one of which consists of pure styrene and some of the distillation assistant while the other fraction consists of a mixture of contaminants and distillation assistant. Preferably not less than 25 percent of the distillation assistant by volume of the crude styrene mixture is employed.

U.S.P. 2,411,160. Beneficiating Mineral Oils. E. C. Hughes to The Standard Oil Company (Ohio).

Mineral oil is beneficiated with a small amount of the reaction product of P_2S_5 and a phenol containing an unsaturated aliphatic side chain, such as occurring in cashew-nut-shell oil. A polymerized phenol of such type can be used instead of the reaction product of such a phenol with P_2S_5. The reaction product is employed in an amount of 0.1-10 percent.

U.S.P. 2,411,208. Purification of Gases. H. J. Hall and J. C. Munday to Standard Oil Development Company.

In order to remove suspended solids from a gaseous stream, particularly powdered catalyst from its suspension in gases, the gaseous stream is passed through a filter bed of coarse granular material, preferably of the same composition as the suspended solids. Coarse material containing powdered material from the suspension is continuously removed from the gas stream at the bottom of the filter zone. This mixed solid material is suspended in a stripping and carrier gas, and the suspension formed is transferred to a point above the filter zone. The coarse granular material is thereafter separated from the carrier and stripping gas and returned to the filter zone. The stripping gas containing the balance of the entrained solids is then combined with the first-named gaseous stream passing to the filtering zone.

U.S.P. 2,411,264. Separation of Hydrocarbons. K. H. Hachmuth to Phillips Petroleum Company.

Butenes, particularly butene-2, are separated from heavier hydrocarbons produced in the manufacture of butadiene by fractionating the hydrocarbon mixture in a column where just enough heat is supplied to the bottom to incompletely remove the butenes from the kettle product. The reboiler section of the column is maintained at such a temperature that polymerization is prevented. The kettle product containing the heavier hydrocarbons in admixture with a substantial portion of butenes is withdrawn and heated in a separate zone to a temperature such that the butenes will be completely driven off. The butenes are reintroduced into the fractionating column at a point closely adjacent the reboiler section, thereby aiding in maintenance of moderate reboiler temperatures.

U.S.P. 2,41,437. Recovery of Aqueous Azeotrope-Former in Azeotropic Distillation of Hydrocarbons. G. R. Lake to Union Oil Company of California.

A complex hydrocarbon fraction containing different components ordinarily boiling within the same temperature range is distilled in the presence of an azeotrope-former and water to produce an azeotropic distillate consisting of at least one class of chemically similar components contained in the complex fraction together with the azeotrope-former and water. At least one other class of chemically similar components different from said first-named class is left in the distillation residue. The azeotropic distillate is dehydrated with a dehydrating agent, such as clay, carbon, or alumina. The azeotropic distillate is then

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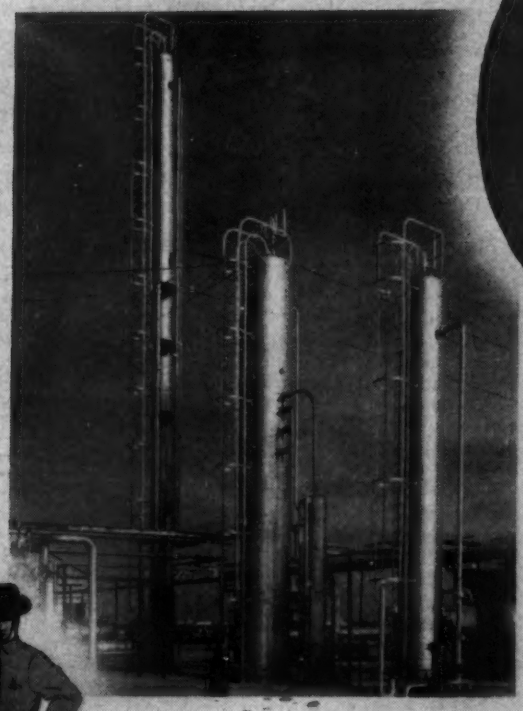

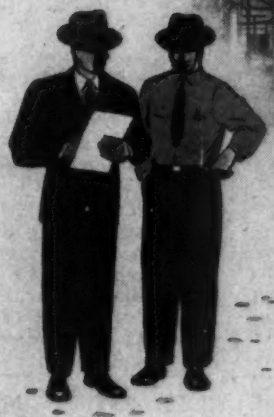

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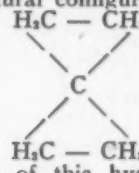
separated from the dehydrating agent and water and is fractionated, preferably at reduced pressure, to separate the azeotrope-former from the hydrocarbons. Methyl ethyl ketone can, for example, be used as the azeotrope-former.

U.S.P. 2,411,502. Treatment of Mineral Oils. L. A. Burrows to E. I. du Pont de Nemours & Company.

Mineral oil is refined, particularly dewaxed, by mixing it with nitrocyclohexane. The solution formed is cooled to a temperature at which segregation into several fractions results, such as formation of two liquid layers or solidification of a portion of the mineral oil. The segregated fractions are separated.

U.S.P. 2,411,582. Aviation Fuel. T. B. McCulloch to Standard Oil Development Company.

The aviation fuel described comprises a major portion of hydrocarbons boiling in the gasoline-boiling range or of isoparaffinic hydrocarbons, and a minor portion of spiropentane, a hydrocarbon of the structural configuration



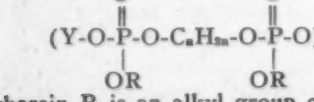
5-25 percent of this hydrocarbon are preferably employed in the fuel composition. The fuel performance both during cruising conditions and during "take-off" or climbing conditions is improved.

U.S.P. 2,411,588. Concentration of Diolefins. J. W. Packie and W. S. Craft to Standard Oil Development Company.

A mixture of saturated and unsaturated hydrocarbons including diolefins, such as butadiene, is countercurrently contacted with an aqueous solution of an ammoniacal cuprous salt, such as cuprous acetate. Unsaturated hydrocarbons are absorbed in this solution which is then stripped with a diolefin-containing gas. The stripped solution is heated to a temperature of 60-90° F. to release substantially pure diolefins as the desired product. Thereafter the solution is heated further to a temperature of 150-180° F. to release the remainder of the diolefins as an impure product which is used as the stripping gas.

U.S.P. 2,411,671. Mineral Oil Composition Resistant to Foaming. H. G. Smith and T. L. Cantrell to Gulf Oil Corporation.

The mineral oil composition described in this patent comprises a major amount of a mineral oil and an amount at least sufficient to reduce the foaming tendency of this oil of a salt of an alkyl alkylene diphosphate of the formula:



wherein R is an alkyl group containing 1-18 C atoms, Y is a substituent of the class consisting of a monovalent metal and alkyl groups, X is a constituent of the class consisting of metals and an organic ammonium group derived from heterocyclic nitrogen bases or dialkylaryl amines, m is a number corresponding to the valence of X, and n is 2-6. Potassium tri-octyl ethylene diphosphate in an amount of 0.01-1.0 percent by weight can be used for this purpose.

U.S.P. 2,411,808. Separation of Hydrocarbons from Water-Miscible Liquids by Distillation and Washing. W. H. Rupp and R. O. Wright to Standard Oil Development Company.

A normally gaseous hydrocarbon, such as isobutylene, is separated from a water-miscible organic liquid, such as alcohols, and a higher hydrocarbon immiscible with water, such as isobutylene polymers, by treating the mixture in a fractionating zone. The normally gaseous hydrocarbon is removed overhead. Scrubbing water is introduced into an upper part of the fractionating zone, diluting the water-miscible organic liquid so that dissolved normally gaseous hydrocarbons are rejected from the liquid. The admixed higher-boiling hydrocarbon liquid is separated from the diluted water-miscible liquid. The separated hydrocarbon liquid is stripped to remove dissolved normally gaseous hydrocarbon therefrom. The process is particularly adapted for fractionating and stripping isobutylene out of the mixed product obtained when regenerating isobutylene from an acid solution thereof.

U.S.P. 2,411,958; 2,411,959. Method of Purifying Petroleum Products. M. A. Dietrich and C. J. Pedersen to E. I. du Pont de Nemours & Company.

Petroleum products which are contaminated with dissolved catalytically active compounds of heavy metals, such as copper, iron, cobalt, manganese, and vanadium are, according to U.S.P. 2,411,-958, washed in the liquid state with a dilute aqueous solution of an organic thiol containing 1-10 C atoms and, in addition to the thiol group, at least 1 water-solublizing group, such as —OH, —COOM, SO_2M, —SO_3M, —PO_2MM, —PO_3MM wherein M represents hydrogen, ammonium, or alkali metal. For example, sodium thioglycolate or thiosorbitol can be used for this purpose. The metallic contaminants are completely removed.

According to U.S.P. 2,411,959 a dilute aqueous solution of thiourea, thiosemicarbazide, N-guanylthiourea, beta-amino ethyl mercaptan, or dithiourea is used for removal of the contaminants.

U.S.P. 2,412,010. Purification of Toluene. W. L. Rippeteau to Phillips Petroleum Company.

A close-cut aromatic-hydrocarbon fraction containing undesirable unsaturated hydrocarbon impurities, such as a close-cut toluene fraction, is distilled in the presence of anhydrous $AlCl_3$ and metallic Fe causing the unsaturated hydrocarbon impurities to combine with the $AlCl_3$ to form a sludge-like material. The metallic Fe is disposed in the vapor-phase portion of the distillation apparatus and the $AlCl_3$ is disposed in the liquid-phase portion. The metallic Fe promotes the formation of the sludge-like material.

U.S.P. 2,412,220. Treatment of Fluorine-Containing Hydrocarbon Mixtures. G. A. Ibach and C. C. Tate to Phillips Petroleum Company.

Hydrocarbon materials containing minor amounts of fluorine compounds as impurities are contacted with bauxite containing siliceous material under conditions such that fluorine is retained by the bauxite and silicon tetrafluoride is formed from the siliceous material. The effluent from this treatment is contacted with an aqueous alkaline solution to remove the silicon tetrafluoride from the hydrocarbon material.

U.S.P. 2,412,427. Refining of Low-Grade Hydrocarbon Oils. E. H. Records.

A body of low-grade hydrocarbon oil to be refined is charged to a retort in such a quantity as to leave a vapor dome of relatively large capacity. The charge is heated in the closed vessel to develop a pressure of about 200 psi. The vapors evolved are then drained off and condensed. The remaining liquid is again sealed within the retort and the pressure is raised to about 850 psi by continued heating. The vapors evolved in this step are again passed off and condensed. The residue from this and corresponding treatment of other charges of oil is maintained in a hot state and the very heavy portions are allowed to settle out. The lighter portions of the aggregate of the residues are subjected to repetitive cyclic treatment in the above indicated manner.

CATALYST PREPARATION ACTIVATION AND REGENERATION

U.S.P. 2,411,820. Manufacture of Catalysts. K. D. Ashley and A. O. Jaeger to American Cyanamid Company.

An aqueous alkali metal silicate solution is neutralized by the addition of an acid to form an aqueous slurry of gelatinous silica containing alkali metal salts. This slurry is aged, and glue is added to flocculate the silica. The alkali metal salts are separated by dewatering and washing, e.g., by filtering off the flocculated silica and washing the filter cake. The method is particularly useful in the manufacture of cracking catalysts and of dehydration and dehydrogenation catalysts.

U.S.P. 2,411,829. Catalysts. H. C. Huffman to Union Oil Company of California.

The catalyst according to this patent consists of 1-15 percent beryllia, 1-10 percent of the oxide of a metal from the left-hand column of group VI of the periodic table and an "activated alumina." For example, 5 percent beryllia and 5 percent of chromium oxide or molybdenum oxide may be used. The catalyst is particularly useful in the dehydrogenation of light or normally gaseous hydrocarbons, such as propane, butane, or the like and in the production of improved motor fuel from commercial naphthas and stocks boiling in the gasoline range.

U.S.P. 2,411,996. Method for Catalytic Conversion. L. S. Kassel to Universal Oil Products Company.

Hydrocarbons are contacted with subdivided solid catalyst in a reaction zone maintained under conversion conditions while an oxygen-containing gas is simultaneously passed through a mass of contaminated catalyst particles in a regenerating zone maintained at combustion temperature. Regenerated catalyst is supplied by gravity flow to the upper portion of the reaction zone from a separating zone disposed at higher elevation than the reaction and regeneration zones. Contaminated catalyst particles are supplied by gravity flow to the upper portion of the regenerating zone from a second separating zone disposed at a higher elevation than the reaction and regeneration zones. Contaminated catalyst is removed from the lower portion of the reaction zone, while regenerated catalyst

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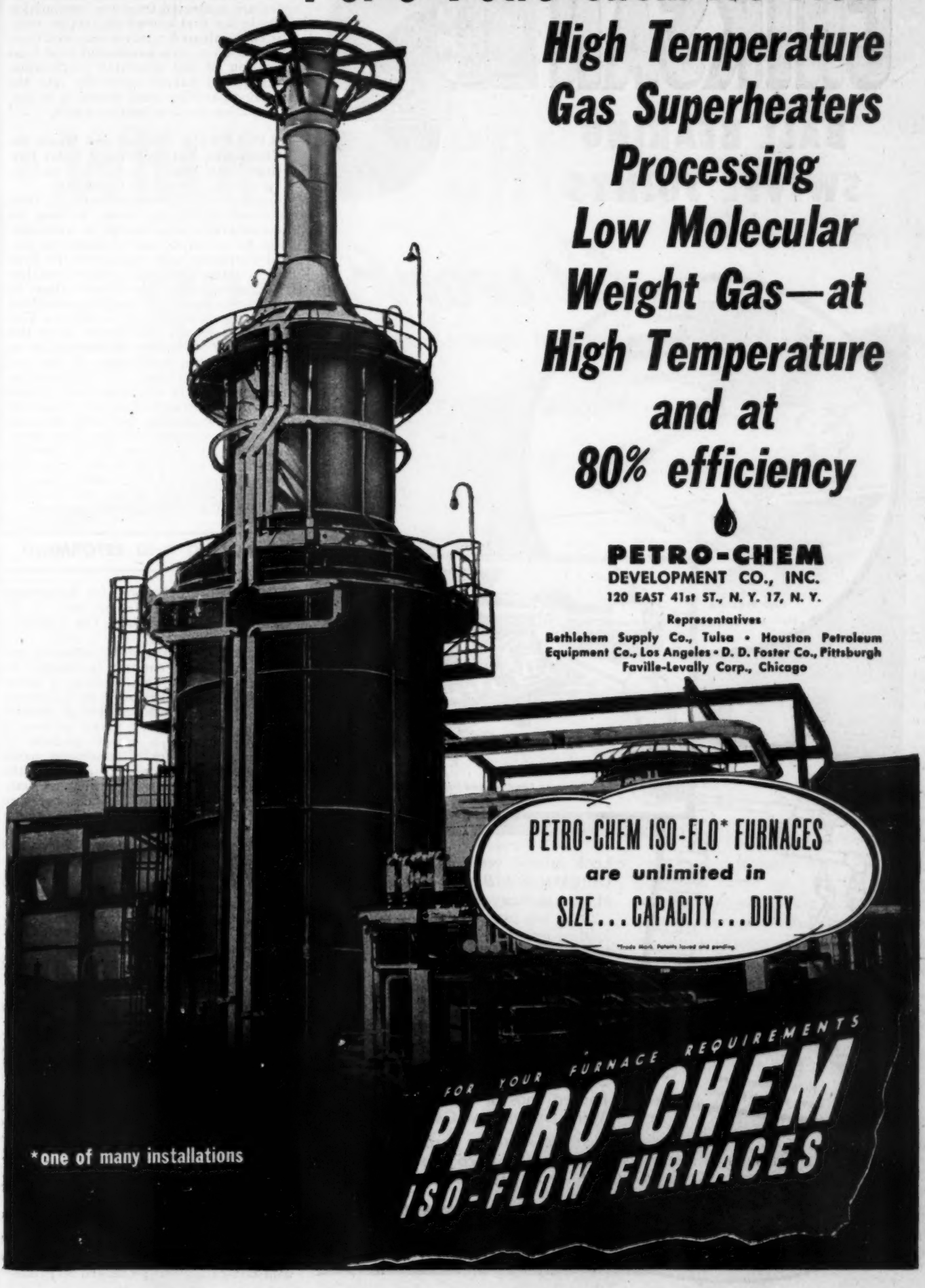

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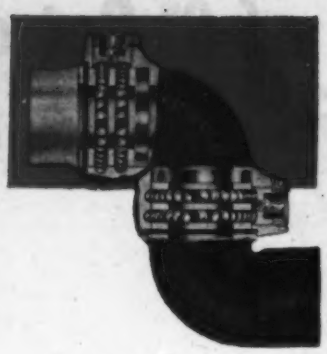

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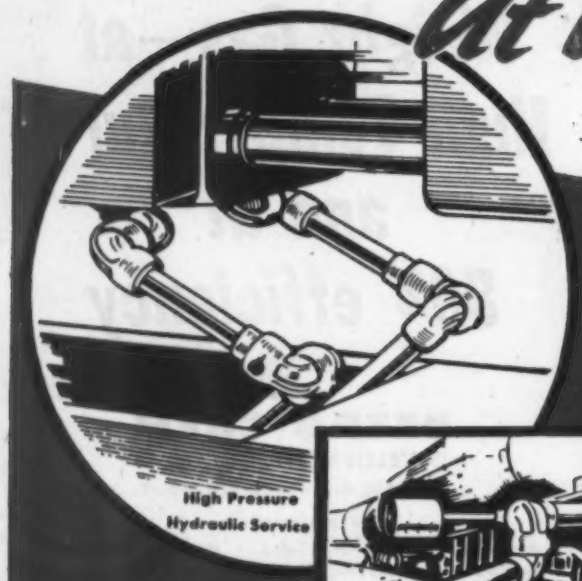

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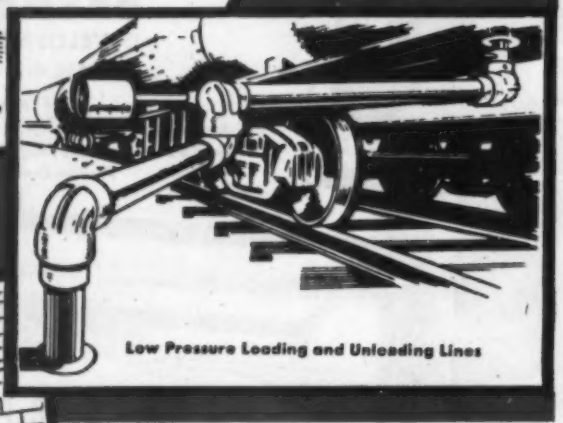

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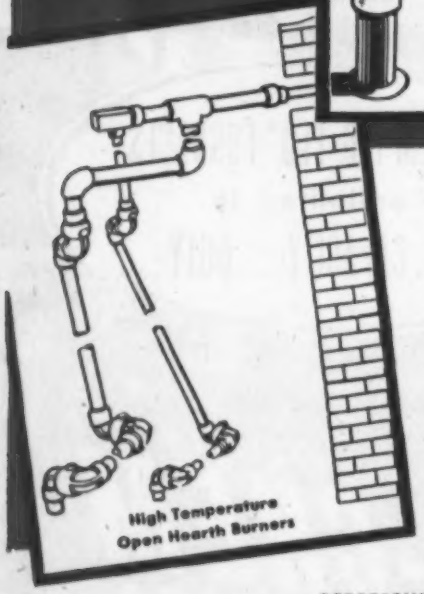

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is removed from the lower portion of the regenerating zone. The regenerated particles are separated from the combustion gases in the first-named separation zone. The contaminated catalyst removed from the reaction zone is suspended in at least a portion of the separated combustion gases and is passed upwardly into the second separating zone where it is separated from the combustion gases.

U.S.P. 2,412,152. Method and Means for Contacting Finely Divided Solid Particles with Fluids. L. C. Huff to Universal Oil Products Company.

Catalyst particles are transferred from an upper contacting zone, serving for the conversion of a stream of hydrocarbons, to a lower zone disposed in vertical alignment with respect to the first-named zone. The contaminated catalyst is regenerated in the lower zone by means of a stream of oxygen-containing gases under combustion conditions. Catalyst particles are withdrawn from this lower zone vertically downward in an annular column while one of the said streams (hydrocarbons or oxygen-containing gases) is simultaneously passed upwardly in straight-line flow in a confined path extending vertically through the annular column and the lower zone. The catalyst particles of the annular column are suspended in the upwardly-flowing stream and the resultant suspension is discharged from the confined path into the upper contacting zone.

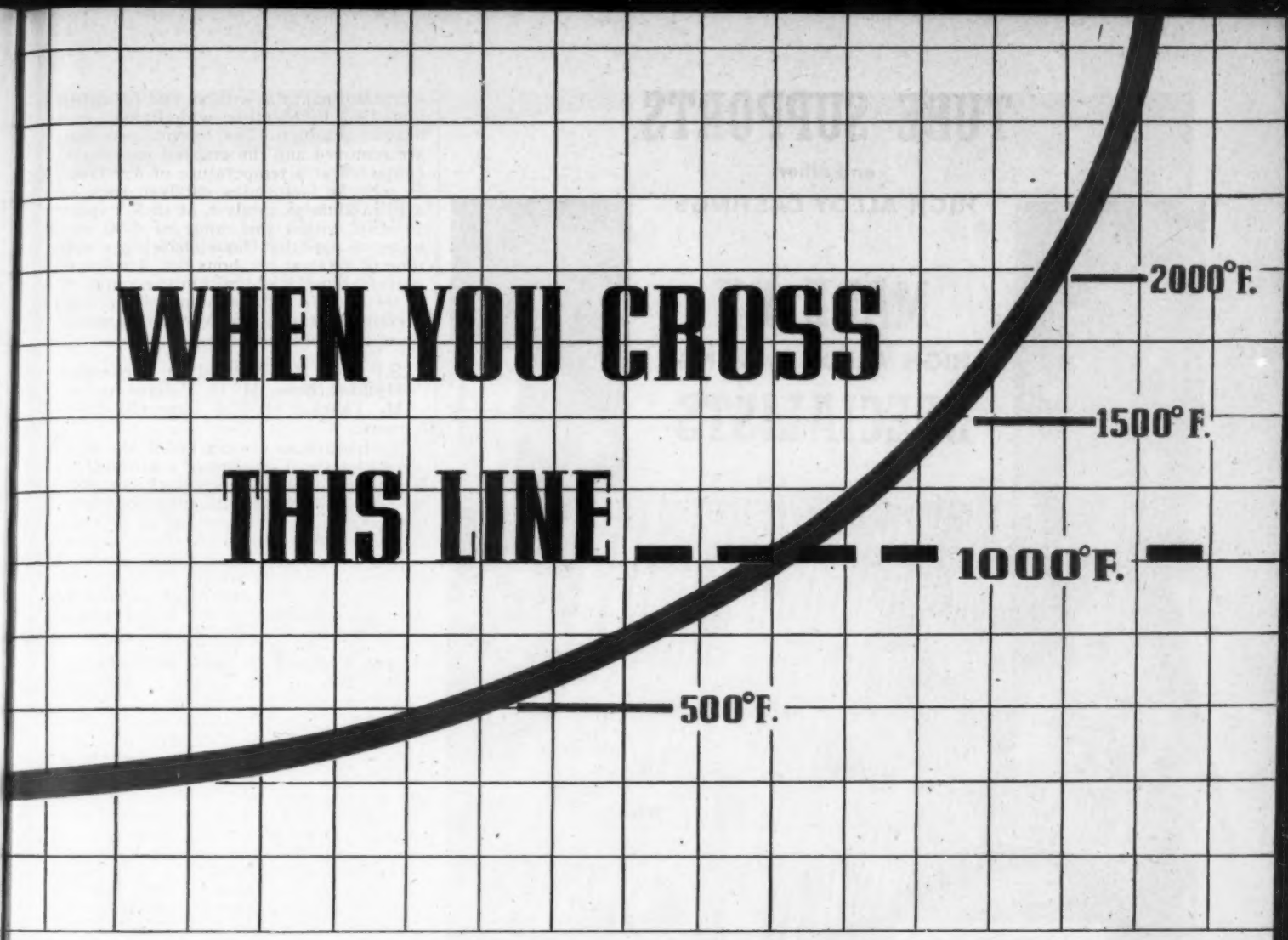
CRACKING AND REFORMING

U.S.P. 2,410,891. Process for Improving Naphtha. R. N. Meinert and P. H. Holt, 2nd to Standard Oil Development Company.

A mixture of hydrogen-containing gas and a petroleum naphtha is charged to a reaction zone which contains a lower dense-phase suspension and an upper dilute-phase suspension of a powdered catalyst consisting of a major portion of zinc spinel and a minor portion of chromium oxide or molybdenum oxide in gasiform reactants comprising the naphtha undergoing reforming. A temperature of 850-1100° F. and a pressure of 15-50 psi is maintained in the reaction zone. Reformed naphtha is continuously withdrawn from an upper portion of this zone and fouled catalyst from a lower portion thereof. The withdrawn catalyst is mixed with oxygen-containing gas and passed to a regeneration zone in which there exists a lower dense-phase suspension and an upper dilute-phase suspension of powdered catalyst in oxygen-containing gas. Regenerated catalyst is continuously withdrawn from a lower portion of the regeneration zone and returned to the reaction zone. The reaction zone is maintained at reaction temperature by increasing or decreasing the amount of hydrogen fed to this zone in accordance with the temperature trend. The amount of carbonaceous material formed on the catalyst during the reaction is such that the heat released during the regeneration of the catalyst is sufficient to maintain the reaction zone at the desired temperature.

U.S.P. 2,410,908. Isoforming. E. W. Thiele, G. E. Schmitkons, and C. M. Hull to Standard Oil Company (Indiana).

A charging stock consisting of gasoil and heavier hydrocarbons is thermally and non-catalytically cracked to produce



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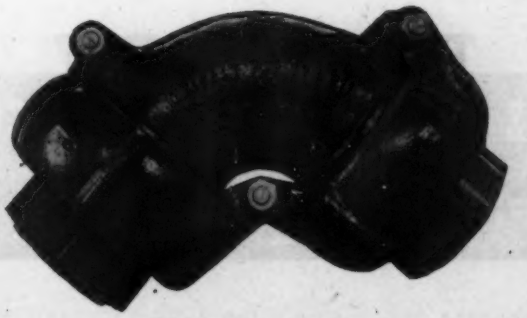

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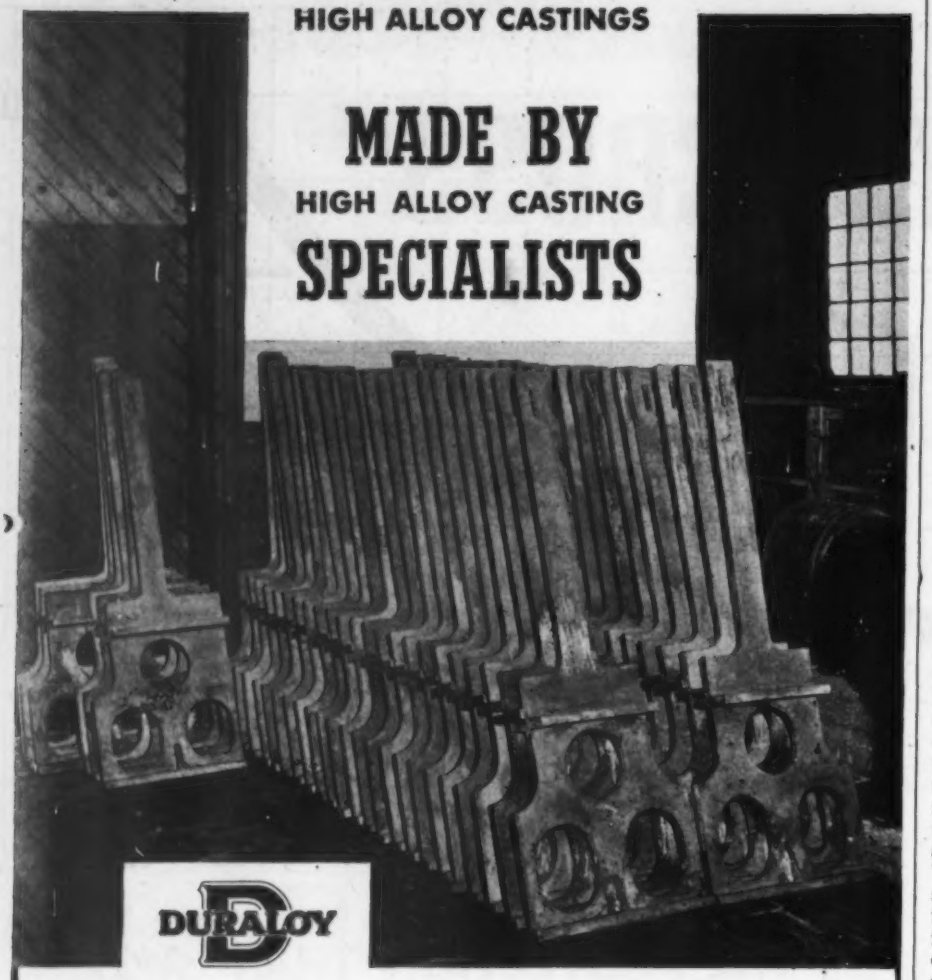

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a cracked naphtha with an end point below 450° F. together with lighter and heavier products. The heavier products are removed and the cracked naphtha is contacted at a temperature of 850-1100° F. with an isoforming catalyst, such as a silica-alumina catalyst, at such a space velocity within the range of 4-40 volumes of naphtha (liquid base) per volume of catalyst per hour that a volume-percent liquid yield within the range of 94-99 and an octane number improvement of at least 5 ASTM octane number units are obtained.

U.S.P. 2,411,200. Method for Converting Hydrocarbons. H. O. Folkins and C. M. Thacker to The Pure Oil Company.

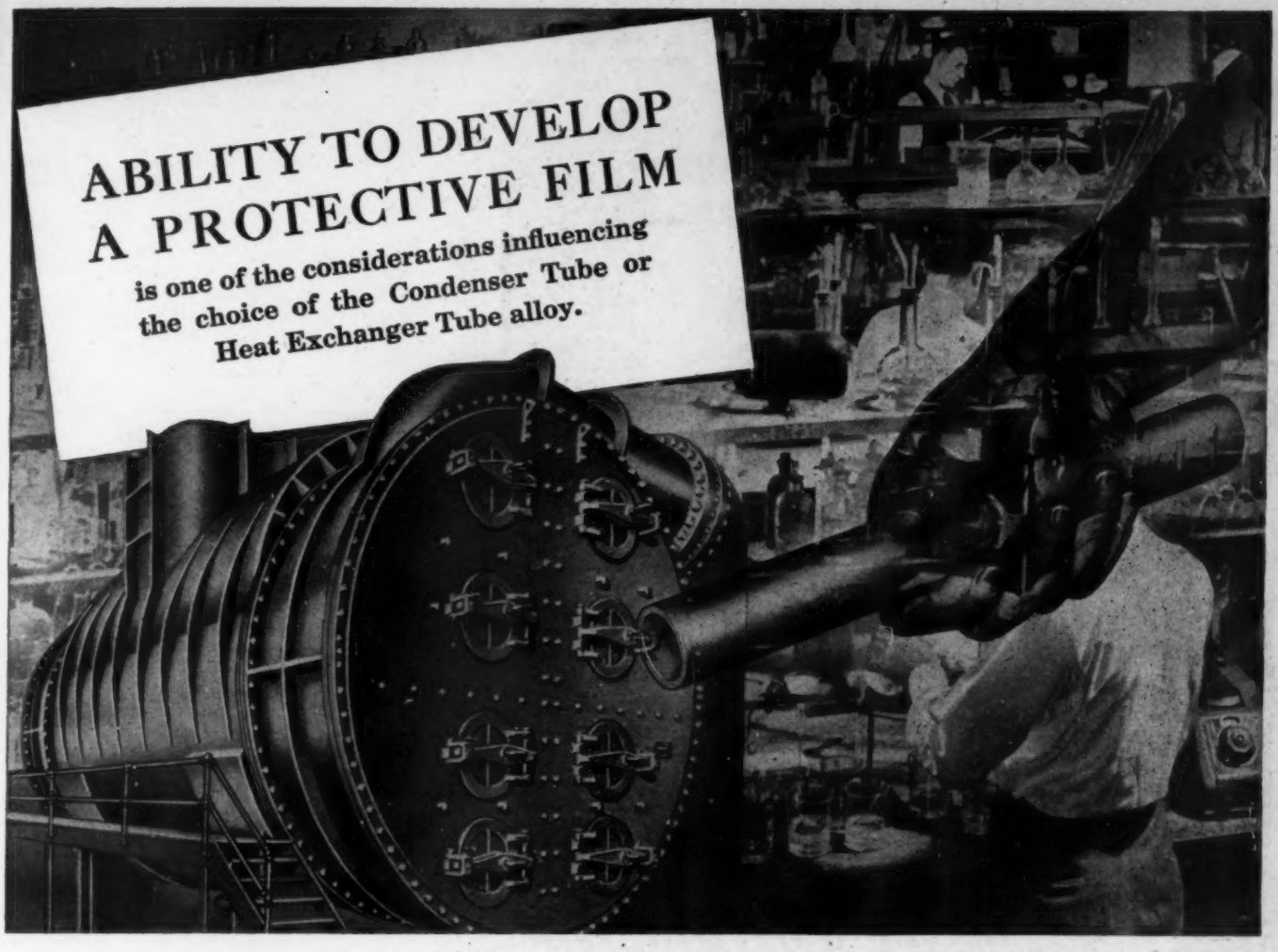
Hydrocarbons are cracked in the presence of a small amount of a brominated or a polybrominated ester, such as methyl or ethyl bromoacetate. Hydrocarbons comprising a large portion of propane can, for example, be cracked at a temperature of 650-2000° F. in the presence of 0.005-3 percent by weight of the brominated ester. The sensitizer accelerates the decomposition of the hydrocarbons to be treated.

U.S.P. 2,411,603. Cracking of Hydrocarbon Oils. C. W. Tyson to Standard Oil Development Company.

In the catalytic conversion of hydrocarbon oils wherein a catalyst in subdivided form is continuously circulated in admixture with oil vapors through a conversion zone and in admixture with oxidizing gas through a regeneration zone, a body of catalyst from one of these zones is withdrawn to a storage zone. Part of this catalyst is periodically transferred to a sealing zone separate and independent from the storage zone. The pressure on the catalyst within the sealing zone is increased and catalyst from this zone is periodically transferred to a feeding zone separate and independent of both the storage and the sealing zones. Catalyst from the feeding zone is continuously discharged into a stream of gaseous material passing through the other of said first-named zones, i.e., oxidizing gas passing through the regeneration zone or oil vapors passing through the conversion zone. A mechanical seal is maintained between the storage and feeding zones throughout the operation.

U.S.P. 2,412,096. Process for Treating Hydrocarbons. W. W. Odell to Lion Oil Company.

At least one aeriform stream of preheated hydrocarbon suitable for thermal reaction is passed in the vapor phase at elevated temperature into a reaction zone intermediate the ends of an elongated upright reaction chamber. Another stream comprising a mixture of a combustible fluid and oxygen in which the oxygen is somewhat less than enough for complete combustion of the combustible fluid is simultaneously introduced into another portion of the reaction chamber. Combustion is promoted in this latter stream which is then passed with the burning fluid through a porous bed of hot refractory solids in the reaction chamber wherein combustion reactions are substantially completed. The stream of hot combustion products thus generated is intimately mixed with the first named stream in the reaction zone. At least one valuable reaction product is thus formed. The resultant stream is quenched after a brief reaction period to minimize polymerization. The valuable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product formed is recovered from the quenched stream, and at least a portion of the other combustible reaction products substantially free from N_2, CO and CO_2 is recycled to the reaction chamber as part of one of the streams.

U.S.P. 2,412,371. Manufacture of Gasoline. J. W. Teter to Sinclair Refining Company.

High anti-knock gasolines are obtained by heating hydrocarbon oils to cracking temperature in the presence of finely-divided crystalline aluminum fluoride, which can contain combined moisture. A temperature of 950-1000° F. and a pressure not substantially exceeding 30 psi can suitably be employed in the process.

ISOMERIZATION

U.S.P. 2,410,886. Aluminum Chloride Conversion System. A. P. Lien and E. L. d'Ouville to Standard Oil Company (Indiana).

Paraffinic hydrocarbons boiling within the butane-to-hexane boiling range are contacted under isomerizing conditions with a body of $AlCl_3$ catalyst in the presence of HCl until the catalyst is converted into sludge. At least a part of this sludge is contacted with sulfuric acid of 50-100 percent strength in an amount to effect liberation of substantially all available HCl in the sludge. The liberated HCl is cycled to the hydrocarbon treatment.

U.S.P. 2,410,894. Isomerization of Normal Butane to Isobutane. C. W. Montgomery to Gulf Research & Development Company.

N-butane vapor is contacted at a temperature of 20-150° C. with a solution or suspension of an aluminum-halide catalyst in a liquid which does not form stable addition complexes with aluminum halides and does not react with them to produce undesirable by-products. A ratio of aluminum halide to n-butane is maintained which is greater than the ratio of these components in a saturated solution of aluminum halide in liquid n-butane at the contacting temperature. A liquid paraffin, such as isopentane, may be used as the catalyst solvent.

U.S.P. 2,411,054. Catalytic Conversion of Hydrocarbons. E. F. Pevere to The Texas Company.

A mixture of n-butane, minor proportions of isobutane, and 0.5-10 percent by volume of a normally-gaseous olefin, such as ethylene, is contacted in liquid phase with an aluminum halide catalyst and a hydrogen halide promoter at a temperature of 100-175° F., under conditions such that isomerization of n-butane to isobutane constitutes the principal reaction and the production of normally-liquid branched-chain paraffin hydrocarbons higher boiling than n-butane constitutes a substantial but minor reaction. Hydrocarbon reaction products are removed, isobutane is separated as a principal final product, and a normally-liquid fraction consisting essentially of the higher-boiling branched-chain paraffins is also separated. An intermediate fraction consisting essentially of unconverted n-butane with a minor proportion of isobutane, is recycled to the reaction zone. The amount of n-butane converted into isobutane is considerably increased by the presence of the small proportions

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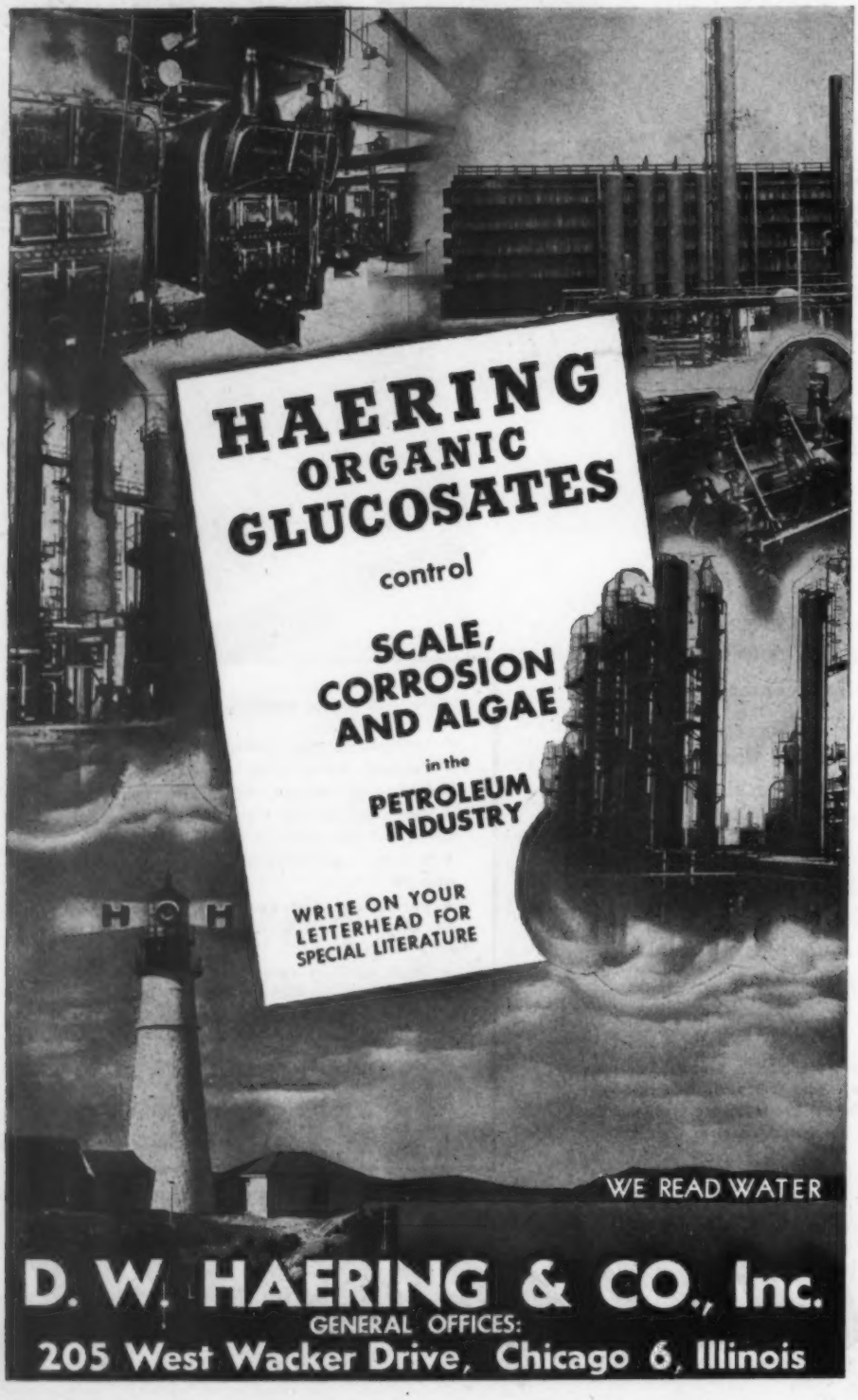
of isobutane and olefin in the reaction mixture.

U.S.P. 2,411,211. Isomerization Process. R. W. Henry to Phillips Petroleum Company.

A butane-hydrocarbon fraction containing less than 0.5 mol percent of pentanes or heavier hydrocarbons and essentially free from unsaturated hydrocarbons and non-hydrocarbon impurities is contacted in vapor phase with a solid Friedel-Crafts metal halide catalyst combined with a solid granular adsorptive material in a first reaction zone under isomerization conditions. Effluent from this zone is fractionated to separate isobutane therefrom. A liquid residual fraction of unconverted butane is treated in a second reaction zone with a liquid Friedel-Crafts metal halide-hydrocarbon complex catalyst under liquid-phase isomerization conditions. Effluent from this second zone is fractionated together with the effluent from the first zone for the separation of isobutane.

U.S.P. 2,411,835. Isomerizing Hydrocarbons. W. E. Ross and G. J. Carlson to Shell Development Company.

Paraffin hydrocarbons with 5-10 C atoms, such as n-pentane, are isomerized by contacting them in admixture with a hydrogen halide promoter with a catalyst in the form of a fluid melt consisting of a dilute solution of a metal halide of the Friedel-Crafts type in a molten metal halide salt of another type. The ratio of fluid melt to hydrocarbons to be isomerized varies from about 1:5 to about 3:1. Spent catalyst is separately withdrawn from the reaction zone as fast as it is formed. A solvent comprising paraffinic hydrocarbons with 4 C atoms is passed through a supply-vessel containing a supply of the metal halide in the absence of hydrogen halide promoter to dissolve the metal halide in the solvent. The solution formed is passed to the reaction zone in controlled amounts to introduce metal halide at a rate substantially equal to the rate at which spent metal halide catalyst is removed from this zone. The solvent is separated from reaction products and hydrogen halide in the product separating zone and then passed to the supply-vessel.



ALKYLATION

U.S.P. 2,411,047. Alkylation of Aromatics. C. B. Linn and V. N. Ipatieff to Universal Oil Products Company.

An alkylatable aromatic compound, such as benzene, is reacted with an alkylating agent, such as an olefin (ethylene, propylene, or the like), in the presence of BF_3 and an acid fluoride under suitable condition, e.g., at a temperature of —10° to 400° C. An acid fluoride of sodium or potassium may be used in the process.

U.S.P. 2,411,799. Dealkylation of Alkyl Cyclic Compounds. W. J. Mattox to Universal Oil Products Company.

Mono-alkyl cyclic componds, such as mono-alkyl benzene, are contacted with a catalyst comprising alumina as its essential active ingredient and a hydrogen halide under dealkylating conditions. A completely dealkylated cyclic compound, such as benzene, and hydrogen halide are separated from the products obtained, and the hydrogen halide is recycled. A dealkylation temperature of 450-700° C. is employed.

U.S.P. 2,411,817. Paraffin Alkylation Process. R. B. Thompson and J. A. Chenicek to Universal Oil Products Company.

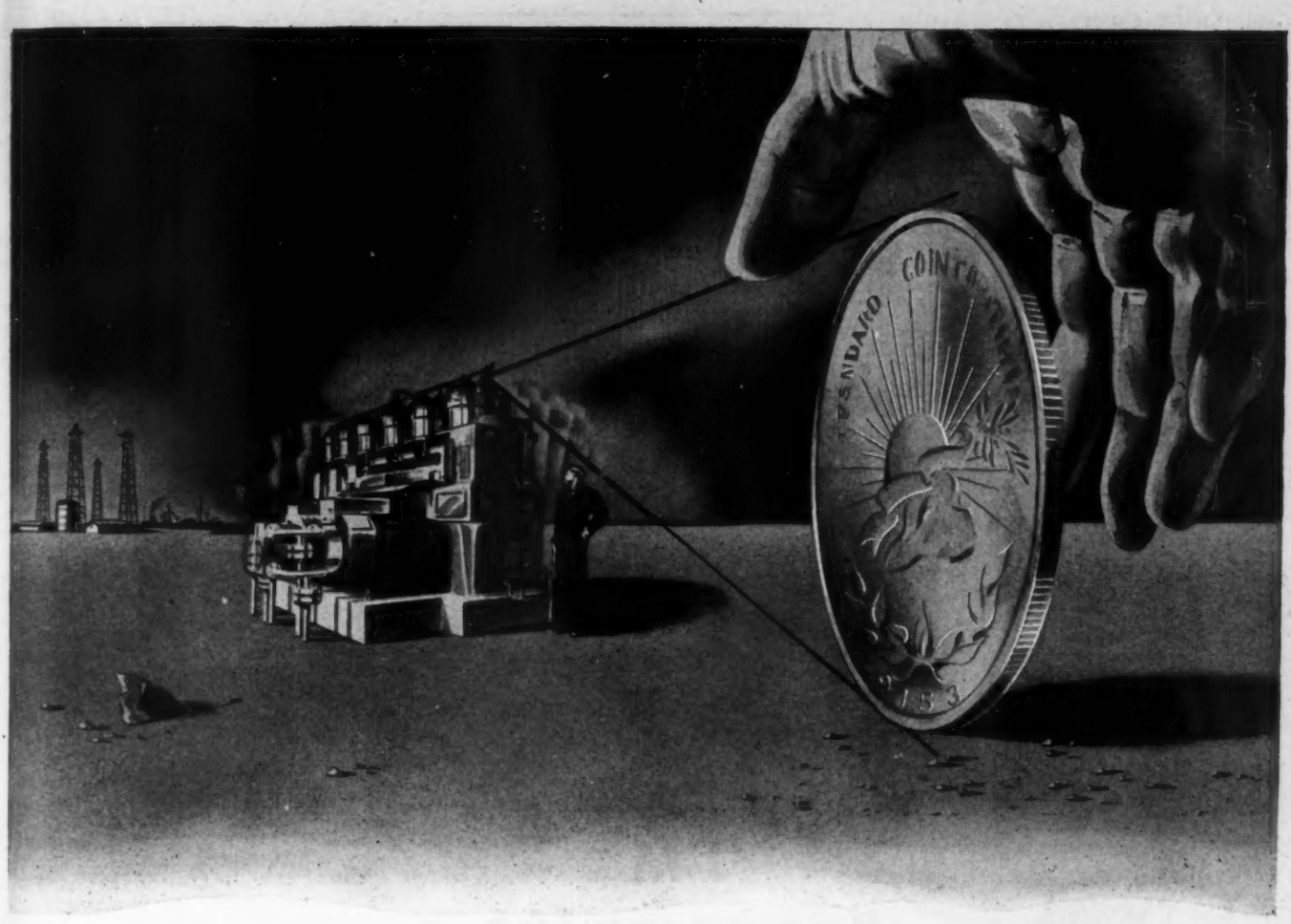
An ethane-ethylene fraction and a heavier fraction containing iso-and normal butane are subjected to alkylation in the presence of an $AlCl_3$ catalyst so that a substantial proportion of the ethylene is reacted with isobutane while supplying an amount of HCl not substantially in excess of that which will react with the remainder of the ethylene. The ethyl chloride formed is separated from the reaction products as an azeotropic mixture with normal butane. At least a portion of the ethyl chloride content of this azeotrope is recycled to the reaction zone. The amount of ethyl chloride formed in and recycled to the reaction zone is sufficient to promote the isobutane alkylation.

U.S.P. 2,411,992. Alkylation of Paraffin Hydrocarbons. A. V. Grosse and C. B. Linn to Universal Oil Products Company.

An isoparaffin, such as isobutane, is reacted with an olefin, such as ethylene, under alkylating conditions in the presence of a catalyst consisting essentially of a major proportion of HF and a minor proportion of BF_3. The temperature employed may vary between —30 and 100° C.

U.S.P. 2,412,229. Alkylation of Aromatic Hydrocarbons. R. E. Schaad to Universal Oil Products Company.

An aromatic hydrocarbon and an olefinic hydrocarbon are contacted under alkylating conditions, e.g., at a temper-



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ature of 100-450° C., in the presence of an alkylating catalyst whose active components consist essentially of a pyrophosphate of a metal from the right-hand column of group I of the periodic table, such as copper.

U.S.P. 2,412,230. Alkylation of Aromatic Hydrocarbons. R. E. Schaad to Universal Oil Products Company.

An aromatic hydrocarbon and an alkoxy compound are contacted under alkylating conditions, e.g., a temperature of 200-450° C. and under a pressure of from atmospheric to about 100 atmospheres, in the presence of a pyrophosphate of a heavy metal from the right-hand column of group I of the periodic table. Ethyl benzene is, for example, obtained by this process from benzene and ethyl alcohol.

POLYMERIZATION AND CONVERSION

U.S.P. 2,411,256. Conversion of Hydrocarbons. F. E. Frey to Phillips Petroleum Company.

A mixture of ethylene and acetylene in a molal ratio of from 10:1 to 50:1 is passed through a reaction zone at a temperature of 871-881° C. and under a pressure of 0.2-2 atmospheres for about 0.14-0.23 seconds. Butadiene is recovered from the reaction mixture.

U.S.P. 2,411,483. Corrosion Inhibition in Catalytic Hydrocarbon Conversion. A. Wachter and R. S. Treseder to Shell Development Company.

In the catalytic conversion of hydrocarbons in the presence of a preformed organo-metal halide complex catalyst, which is in direct contact with a metal-containing surface of the reaction zone, antimony or antimony halides, preferably in amounts of 0.1-6 percent by weight, are added to the catalyst to inhibit corrosion of said surface and increase the useful life of the catalyst.

U.S.P. 2,411,760. Method and Apparatus for Catalytic Conversion. E. E. Sensel to The Texas Company.

A gaseous stream containing CO and H_2 is passed downwardly through a plurality of separate porous beds of synthesis catalysts in solid particle form, such as Co, Fe, or Ni together with a promoter, maintained in series and spaced a substantial distance apart from each other within a tower. A porous bed of non-catalytic solid particles is deposited in intervening spaces between catalyst beds so that vapors flowing from an upper catalyst bed to a lower catalyst bed are passing through the porous bed. Conversion of CO and H_2 into higher-molecular-weight compounds is effected at a predetermined elevated temperature in the catalyst zones with evolution of heat. Liquid coolant obtained from an outside source is flown through each non-catalytic bed in intimate contact with said vapors to effect cooling and in sufficient amount and at such temperature as to effect liquefaction of the higher-molweight constituents of the reaction mixture. Liquid is separated from the vapors after passage through each non-catalytic bed and prior to passage through the succeeding catalyst bed. The amount of liquid thus withdrawn is regulated so as to prevent liquid overflow into a succeeding catalyst bed.

U.S.P. 2,411,822. Liquid Phase Dimerization. T. F. Doumani to Union Oil Company of California.

A hydrocarbon mixture containing a conjugated diolefin with less than 7 C atoms and a mono-olefin with approximately the same boiling point as the diolefin is subjected to a temperature above the critical temperature of the diolefin and a pressure above its critical pressure in the presence of a liquid straight-run petroleum distillate boiling above the gasoline range. The reaction mixture is maintained in liquid phase and the diolefin is dimerized without substantial polymerization of the mono-olefin. Butadiene, isoprene or cyclopentadiene can, for example, be dimerized by this process. A temperature of 100-300° C. is employed.

U.S.P. 2,411,823. Catalytic Process. T. F. Doumani and J. F. Cuneo to Union Oil Company of California.

Unsaturated ketones are produced by reacting an olefin with an acid anhydride of a saturated aliphatic carboxylic acid of not more than 4 C atoms in the presence of acetyle sulfoacetic acid as the catalyst. Diisobutylene can, for example, be treated by this process with acetic anhydride.

U.S.P. 2,412,025. Catalytic Conversion of Hydrocarbons. G. B. Zimmerman to Universal Oil Products Company.

A fluid reactant is endothermically reacted in the presence of subdivided solid catalyst in a reaction zone, while solid catalyst is exothermically regenerated in a regenerating zone. A relatively dense catalyst bed is maintained in each of these zones. A first and second stream

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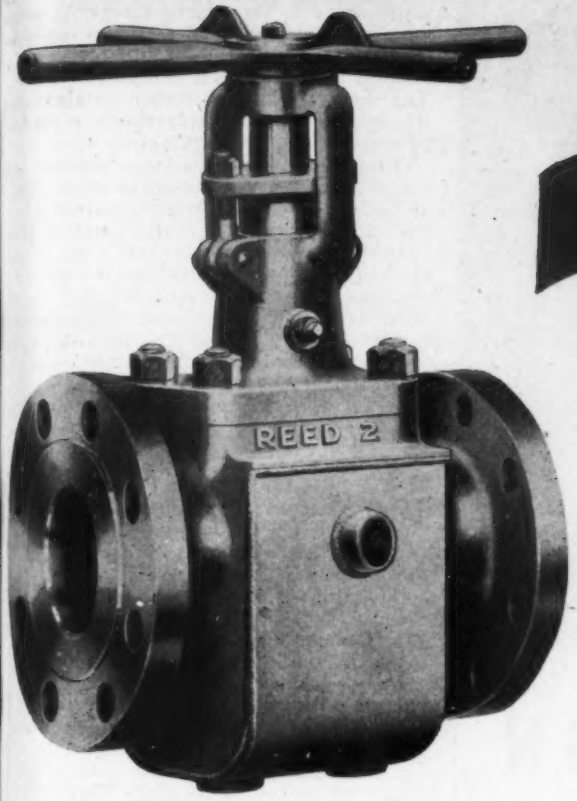

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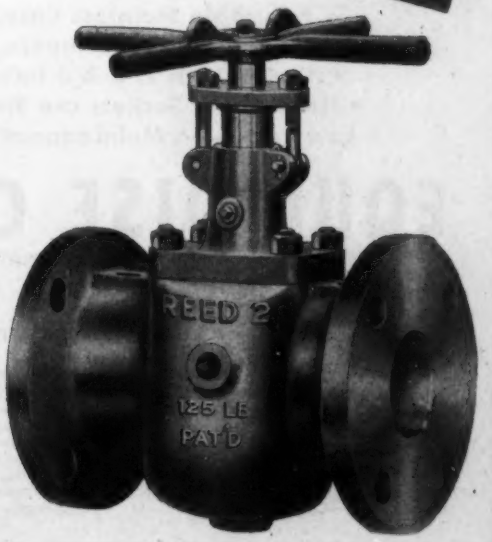

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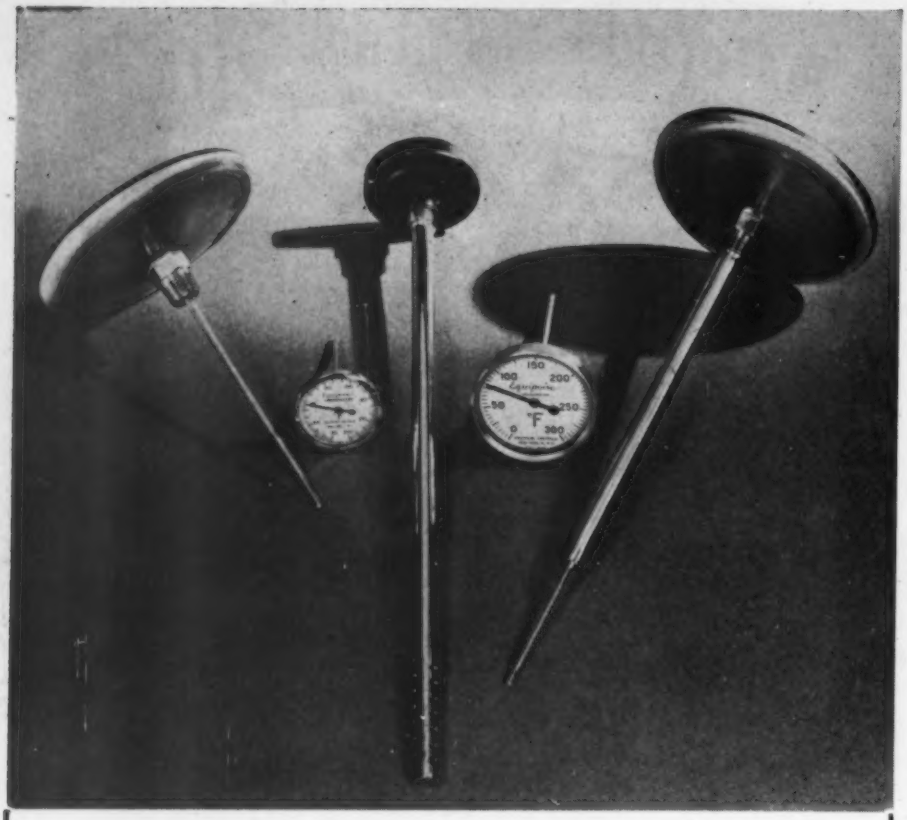

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of heated catalyst is removed from the regenerating zone at spaced points below the upper surface of the bed and a first and second stream of cooler catalyst is simultaneously removed in a corresponding manner from the reaction zone. The first stream of heated catalyst is transported to the reaction zone in suspension in at least a portion of the fluid reactant and introduced into the lower portion of the catalyst bed in this zone. The first stream of cooler catalyst is transported to the regeneration zone in suspension in an oxygen-containing gas and introduced into the lower portion of the catalyst bed in this latter zone. The second stream of heated catalyst and the second stream of cooler catalyst are passed in indirect heat exchange with each other. Thereafter the second stream of heated catalyst is commingled with the first stream of cooler catalyst which is being transported to the regenerating zone. The second stream of cooler catalyst from the heat exchanger is commingled with the first stream of heated catalyst which is being transported to the reaction zone.

U.S.P. 2,412,135. Method and Apparatus for Hydrocarbon Conversion. L. P. Evans to Socony-Vacuum Oil Company, Inc.

Particle-form solid contact mass material is flown downwardly as a moving column through a reaction zone under reaction conditions of temperature and pressure, while heated substantially vaporous hydrocarbons are introduced into this column. Reaction products are removed from the column, and contact mass is removed from the reaction zone by subdividing the column into a plurality of equal components distributed uniformly across the cross-sectional area of the reaction zone in a single plane, the cumulative cross-section area of these components being less than the cross-sectional area of the reaction zone column. These components are caused to converge at angles with the vertical less than about 45°. The components then are combined into a single flowing discharge column of less cross-sectional area than the reaction zone column, and the rate of flow in this discharge column is controlled uniformly throughout its cross-section in such a manner as to maintain continuity of solid-material column from the flowing discharge column through each of the components to the reaction-zone column.

U.S.P. 2,412,136. Method and Apparatus for Hydrocarbon Conversion. L. P. Evans and F. E. Ray to Socony-Vacuum Oil Company, Inc.

The process according to this patent is similar to that of U.S.P. 2,412,135. In the present case contact mass from the reaction zone is conducted from the bottom of the column in a plurality of streams from a plurality of points, these streams being of less total cross-sectional area than the column. The size and arrangement of the streams across the cross-sectional area of the column bottom is such as to provide substantially uniform stream cross-sectional area per unit of column cross-sectional area across the entire column bottom. These streams are conducted to the first of a series of accumulation points of solid material located below the column. From the bottom of each of these accumulations is similarly withdrawn a smaller number of streams of the solid material. The streams from each accumulation are horizontally staggered proportionately as

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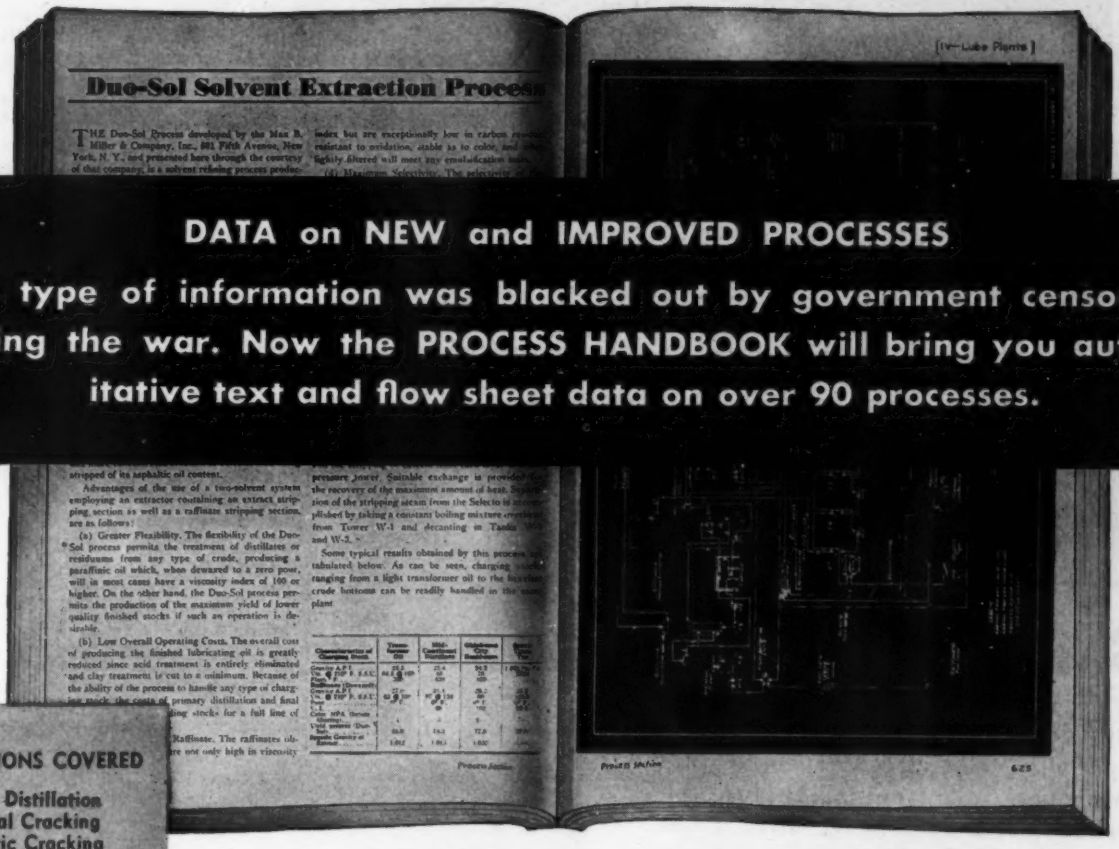

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regards cross-sectional area with respect to the streams thereabove. The number of streams is finally reduced to a symmetrically placed single discharge stream while maintaining continuity of solid material from the bottom of the conversion-zone column through said streams and accumulations to the discharge stream. A complete and uniform utilization of all portions of the flowing stream of contact mass is thus attained in both the reaction and the regeneration zone.

U.S.P. 2,412,143. Separation and Recovery of Soluble Catalyst in Hydrocarbon-Conversion Reactions. M. H. Gorin and W. Swerdloff to Socony-Vacuum Oil Company, Inc.

A low-temperature hydrocarbon-conversion reaction, such as alkylation or isomerization, is carried out in the presence of at least one liquid hydrocarbon containing dissolved catalyst. The effective catalyst agent has a boiling point above that of the desired conversion product. Liquid reaction mixture containing reaction product, liquid hydrocarbon solvent, and dissolved catalyst is withdrawn from the reaction zone and transferred to a separation zone. Product is vaporized from the reaction mixture in this zone and removed. The amount of vaporization is regulated so that sufficient hydrocarbon remains in the liquid state to act as a solvent for the catalyst. The product vapors are condensed, and return of condensed product vapors to the catalyst solution is avoided. The unvaporized portion of the reaction mixture containing dissolved catalyst is recycled to the reaction zone. $AlBr_3$ is the preferred catalyst.

U.S.P. 2,412,504. Treating Styrene and Other Monomers Used in Polymerization Processes. G. Goldfinger to Godfrey L. Cabot, Inc.

In order to improve monomeric vinyl compounds, such as styrene or butadiene, the monomers containing an inhibitor such as hydroquinone are heated to the boiling point while in contact with carbon black. Thereby (1) initial polymerization of a small amount of the monomer is caused, (2) the inhibitor is adsorbed from the monomer, and (3) the initially formed polymer is also adsorbed. Removal of the inhibitor not only expedites later polymerization but also improves the quality of the polymer. Polymer initially formed in the presence of inhibitor has an injurious effect on the quality of the finished product.

HYDROGENATION DEHYDROGENATION AROMATIZATION

U.S.P. 2,411,592. Fluid Catalyst Reactor. E. D. Reeves to Standard Oil Development Company.

Preheated olefins, such as butenes, are dehydrogenated by discharging them into a vertically disposed conversion chamber of restricted cross-section while a fluidized powdered catalyst material is simultaneously discharged into this chamber. The powdered material is caused to gravitate through a foraminous member into a regeneration chamber contiguously disposed immediately below the conversion chamber by regulating the velocity of the gas in this conversion chamber to permit the gravitation. The catalyst is contacted in the regeneration chamber with steam to consume contaminants. The thus revivified

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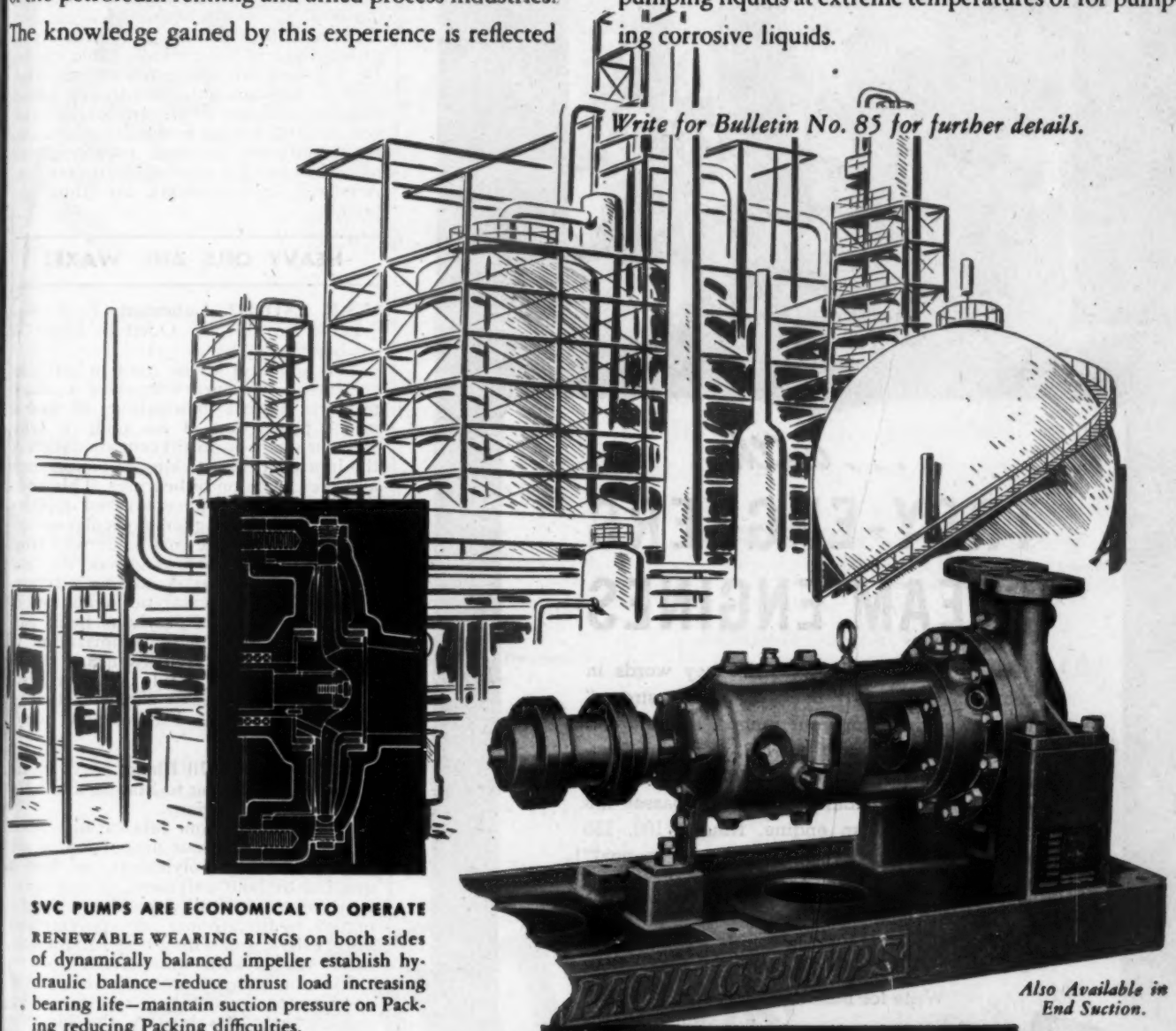

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catalyst is recycled substantially uncooled to a point near the top of the conversion chamber.

U.S.P. 2,411,726. Production of Aromatic Hydrocarbons. R. Holroyd and D. H. P. Peel to Imperial Chemical Industries.

A mixture containing hexamethylene naphthenes and a toxigen, such as sulfur, is treated by separating from this mixture a relatively heavy fraction richer in hexamethylene naphthenes than said mixture and having an initial boiling point between 80° and 120° C. This fraction together with added hydrogen is subjected at a temperature not exceeding 450° C. to the action of a catalyst containing at least one of the metals of group VIII of the periodic table except Fe, Co, and Ni, supported on activated carbon. The amount of hydrogen added shall be sufficient to prevent loss of catalyst activity during prolonged operation, but insufficient to cause predomination of hydrogenation over dehydrogenation. Aromatic hydrocarbons are thus obtained.

HEAVY OILS AND WAXES

U.S.P. 2,411,032. Lubricant. E. F. Engelke and W. W. Odell to Lion Oil Company.

The lubricant to be used in internal-combustion engines comprises a major proportion of a lubricating oil and a minor proportion of an additive sufficient in quantity to prevent oxidation of the lubricant, the sticking of piston rings and the corrosion of bearings. This additive comprises a phosphorized mixture of a soap and a higher-molecular monohydric alcohol. The soap is derived from a heavy metal, such as Ag or Zn, and natural waxes or artificial wax mixtures obtained in the catalytic oxidation of high-molecular hydrocarbons from paraffinic crudes. The phosphorization of the mixture is effected by means of elemental P or P_2O_5. Cetyl, Circyl, myristil or myriscil alcohols or cholesterols may, for example, be used as suitable monohydric alcohols.

U.S.P. 2,411,150. Oil Blend. H. C. Evans and D. W. Young to Standard Oil Development Company.

The hydrocarbon lubricating oil is blended with a minor proportion of soluble thickening polybutene, or hydrogenated diolefin polymers, or condensation polymers of alkyl halides with aromatic hydrocarbons, or polymerized vinyl esters, and with a non-volatile oxy-ester which is a non-solvent for the thickening polymer compounds at ordinary temperature. The oxy-ester is homogeneously dissolved in the blend in an amount sufficient to reduce thickening by the polymer at a temperature below 100° F. and to lower the temperature dependency of the viscosity. The oxy-ester shall precipitate the polymers used from a 10 percent solution in a light hydrocarbon when added at room temperature in amounts of 20-300 percent based on this solution. Triethylene glycol di-2-ethyl butyrate or another high-boiling aliphatic alkoxy or hydroxy ester can, for example, be used as the oxy-ester.

U.S.P. 2,411,153. Mineral Oil Composition and Improving Agent. E. W. Fuller, H. G. Berger, and R. H. Williams to Socony-Vacuum Oil Company.

The mineral oil composition according

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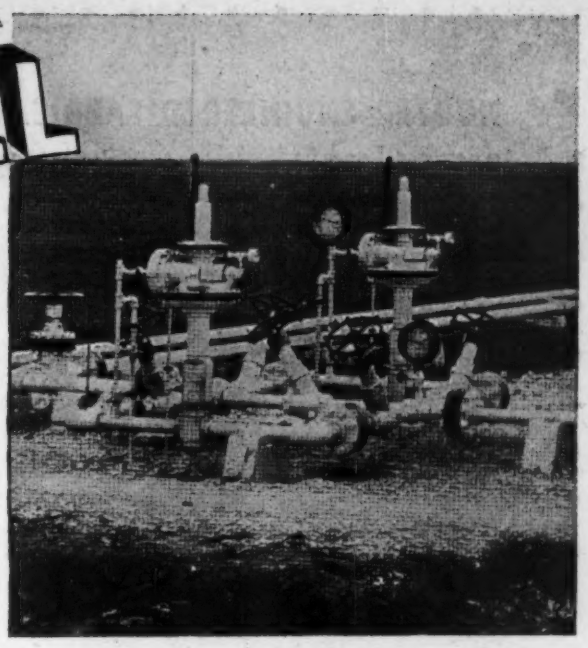

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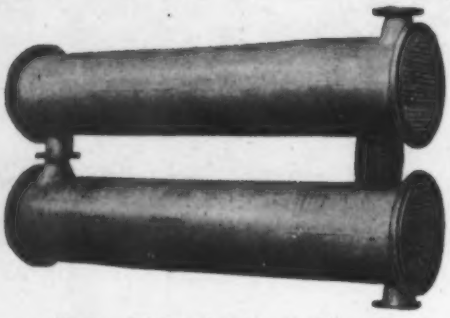

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to the invention comprises a viscous mineral oil and an admixed minor proportion of an oil-soluble phosphorous- and sulfur-containing product obtained by reacting one mol of P_2S_5 and four mols of oleyl alcohol at 125-150° C. The reaction time-reaction temperature relationship is maintained so as to minimize cloud formation in the reaction product, a heating period of two hours being, for example, used at 150° C. The amount of phosphorus- and sulfur-containing reaction product employed may, for example, constitute 0.1-5 percent of the mineral oil. The additive stabilizes the viscous mineral oil against oxidation and deterioration.

U.S.P. 2,411,159. Lubricant. W. E. Hanford to E. I. du Pont de Nemours & Company.

The lubricating composition described in this patent comprises a lubricating oil and a saturated organic polyfluoro compound of the general formula $X(CF_2CF_2)_nY$ wherein X is either hydrogen or a halogen, n is a positive integer greater than 1, and Y is a monovalent saturated organic radical, the compound $H(CF_2CF_2)_7C_4H_9$ being an example of a useful compound of this character. This lubricant is very stable and non-flammable and can be used for lubricating moving parts under extreme conditions.

U.S.P. 2,411,178. Oil Composition. D. W. Young and E. Lieber to Standard Oil Development Company.

The composition comprises a major proportion of a paraffinic hydrocarbon, such as a waxy mineral lubricating oil, and dissolved therein a small amount (less than 5 percent) of a polyester with an average mol weight of at least 2,000 and consisting of a polymeric condensation product of a glycol with a dicarboxylic acid or ester, such as a soluble polyester of methyl dilinoleate and decamethylene glycol. A small amount, (less than 2 per cent), of a pour depressor consisting of a high mol weight condensation product of a long-chain aliphatic compound and an aromatic compound is also dissolved in the composition.

U.S.P. 2,411,492. Method for Treating Waxy Stocks. B. F. Wingrove to Socony-Vacuum Oil Company.

Ash-forming constituents are removed from a wax cake, obtained by dewaxing a waxy petroleum stock by means of a solvent at suitably low temperatures, by adding at least one constituent of this solvent to the waxy cake in an amount substantially in excess of the volume of this cake. The mixture is heated to a temperature above 120° F. but below the boiling temperature of the solvent and water. A relatively small proportion of water is added to said mixture dissolving the ash-forming constituents contained in said cake. The aqueous solution of the ash-formers is then separated from said solvent-wax mixture. A mixture of benzol and methyl-ethyl ketone is, for example, employed in the dewaxing operation.

U.S.P. 2,411,579. Condensation Product and Method of Preparing and Using Same. E. Lieber and M. E. Thorner to Standard Oil Development Company.

The patent relates to a lubricant composition which comprises a major proportion of a waxy mineral lubricating oil and a wax-modifying amount of a Friedel-Crafts condensation product of a lower saturated aliphatic ether of the

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This illustrates another application of Wolverine Trufin, again demonstrating the high performance values this unique tube delivers in compact space.

Air is sucked into the airplane by a fan and routed through the cooler flowing around the outside of the finned tubing, and then dispersed in the main cabin. In this application, Wolverine Trufin contains a mixture of alcohol and carbon dioxide at a temperature of approximately 100° F below the freezing point of water. This mixture is obtained by dropping dry ice into the tank containing methyl alcohol, and is pumped through the cooler as a liquid. This cooling system appreciably lowers the temperature of the cabin for the passengers' comfort during hot weather.

The cooler has 84 individual pieces of Trufin, each 4 inches long. Two coolers are used in the cooling system.

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general formula R-O-R′ where R and R′ are alkyl groups with a total of less than 10 C atoms, with an aromatic hydrocarbon or an alkyl, hydroxy, amino, or partially hydrogenated derivative thereof, this condensation product being nonvolatile up to 500° F. under reduced pressure and soluble in mineral oil. For example, 0.5-10 percent of a pour-depressing Friedel-Crafts condensation product of di-isopropyl ether and naphthalene can be used for this purpose. The preparation of said condensation products is described in U.S.P. 2,411,578.

U.S.P. 2,411,583. Compound Lubricating Oil. J. G. McNab and C. Winning to Standard Oil Development Company.

The composition according to this invention comprises a hydrocarbon oil subject to deterioration at elevated temperatures and a small proportion of a compound of the formula $(M'X)_m$. Ar (R_n). (MO_2S), where M and M′ are metals from groups II, III, VIII and the right-hand column of group IV of the periodic table, X is oxygen, sulfur, selenium or tellurium, R is a branched chain alkyl radical, and m and n are small whole numbers whose sum is not greater than 5, the total number of C atoms in all the R groups being at least 8, and preferably from 8 to 24. The calcium double salt of isohexadecyl phenol sulfonic acid is, for example, used as the mineral-oil additive, resulting in stabilization of the oil.

U.S.P. 2,411,587. Anti-Friction Bearing Lubricant. A. J. Morway and A. Beerbower to Standard Oil Development Company.

The lubricant is an unctuous transparent composition particularly suitable for the lubrication of anti-friction bearings. It is composed of mineral lubricating oil thickened to smooth grease consistency with a mixture of soda and zinc soaps in which the ratio of soda soap to zinc soap is between 14:1 and 28:1. A suitable additive composition consists of 0.5 percent zinc stearate, 1.95 percent caustic soda and 13 percent stearic acid.

Celanese Corporation Making New Products

Celanese Chemical Corporation has reached the stage of commercial production of normal propyl alcohol, which is being added to the other chemicals under production from hydrocarbon raw materials in the plant of Chemcel, near Bishop, Texas. The announcement also included information that the plant shortly will offer propionaldehyde for large scale experimentation and pilot-plant development. Shortly the plant at Chemcel will produce this chemical in tank-car qualities.

Propionaldehyde will be added to the two other members of this family now in production on large-scale volume, formaldehyde and acetaldehyde, which are among the total output of this petrochemical plant.

Total output of the Chemcel plant is being expanded through conversion of equipment which previously was started as a part of the war program. One unit was for the production of butadiene for chemical rubber by a process not used in the larger butadiene units. This equipment is being converted to other products.

The Celanese plant uses a combination of butane and propane as hydrocarbon raw material and one of its products is acetic acid, used in the rayon industry.

NEW EQUIPMENT

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1—Tube Cleaners

Elliott Company, Roto Division, Newark 1, New Jersey, has announced two new jet motors for tube cleaning. Roto Air Jet and Roto Water Jet are driven by air and water, respectively, and the air jet motor also can be adapted to operate with steam.

According to the company's data, power developed by the new air jet motor is so much greater than desired for ordinary tube cleaning that commercials models have been throttled down to operate at only a fraction of potential power; yet they develop more power than previous Roto motors. This motor has only two moving parts, a shaft and a blade.

The Roto Water Jet Motor, less powerful than the air jet, is described as an important advance in water-driven tube cleaners. Radical design changes in the turbine wheel and other parts are involved.

Existing Roto cutter heads and operating hose will fit the new jet motors. The motors are available for most common tube sizes, and other sizes are being added.

Literature is available.

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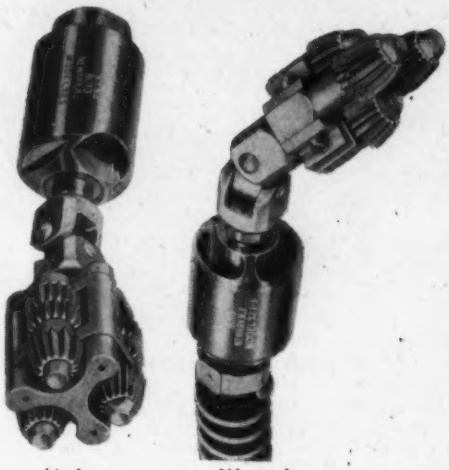

Air Jet Water Jet

2—Vacuum Breaker

Associated Valve & Engineering Company, 1150 West Marquette Road, Chicago 21, is distributing the Schade No. 1724 Vacuum Breaker, designed for extra protection for jacketed kettles, closed tanks, hot-water generator coils and heating units. It is protected by a housing enclosing the spring, preventing alteration of setting through tampering or accidental bumps.

This device prevents collapse by admitting air into the unit when the inside pressure becomes sub-atmospheric beyond a predetermined point.

The vacuum breaker is single-seated, tight-closing and of all-bronze construction. The stainless steel spring can be adjusted for a set absolute pressure. It is furnished in six sizes, from ½-inch pipe thread connection and an overall height of 4⅛-inch to 2-inch pipe thread connection and an overall height of 6¼ inches.

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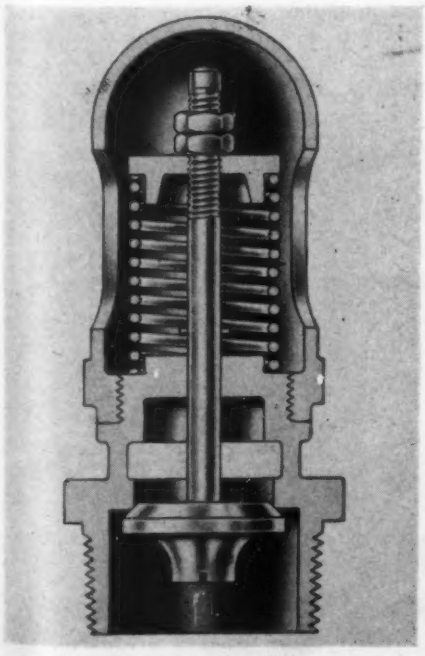


Schade No. 1724 Vacuum Breaker.

3—Turbine Unit Heater

L. J. Wing Manufacturing Company, 154 West 14th Street, New York 11, has introduced the Wing Turbine Revolving Unit Heater, in which the fan is driven by a compact all-steel turbine. The turbine exhaust passes into the heater section where it is used to heat air which the turbine-driven fan then delivers through revolving discharge outlets. Condensate, which is never at a higher temperature than 170° F., is returned to the boiler through an open return system. Advantages claimed, in addition to elimination of other power for the fan, include no back pressure, no packing, and no traps. An available bulletin gives complete details.

CHECK THE CARD AT PAGE 232

4—Stainless-Clad Steels

Lukens Steel Company, 352 Lukens Building, Coatesville, Pennsylvania, has announced it now is offering a complete line of stainless-clad steels—a light layer of the proper type of solid stainless steel is bonded, by hot rolling, to a carbon or alloy steel plate. Bulletins 338 and 255 give details.

CHECK THE CARD AT PAGE 232

5—Solenoid Valve

Henry Valve Company, 3260 West Grand Avenue, Chicago 51, announces production of its Type SV-11 solenoid valve, designed for small-capacity installations involving the use of freon, methyl chloride, water, air, oil, gas, etc. Incorporated in a standard outlet box, it can be mounted through screw holes provided and electrical connections can be made by utilizing one of three knockouts in outlet box. Coil can be removed and replaced without disturbing electrical connections to thermostat or other electrical devices. Efficient magnetic circuit provides low current consumption and "floating plunger" insures quiet operation. Type SV-11 meets all requirements of the Underwriters Laboratory. It is furnished with ⅜-inch FPT connections in following standard voltages: 115 volt, 60 cycle, and 230 volt, 60 cycle. Valve also can be mounted in approved metal enclosure, less outlet box. Lock nuts threaded on body for mounting. Also available with larger outlet boxes where multiple electrical terminals are required. Complete information can be obtained by writing.

CHECK THE CARD AT PAGE 232

6—Portable Vacuum-Leak Detector

Consolidated Engineering Corporation, 620 North Lake Avenue, Pasadena 4, California, is manufacturing a portable leak detector that can locate and measure leaks in vacuum and pressure systems as minute as .00000001 c. c. per second. Based on the mass-spectrometer principle, this instrument electronically

Consolidated Model 24-101 Leak Detector.

separates and measures helium molecules, by reason, only, of their mass, from all dissimilar molecules in the atmosphere. Introduction of helium in suspected areas will give an almost immediate indication on the visual meter or audio alarm system whenever any leakage is present.

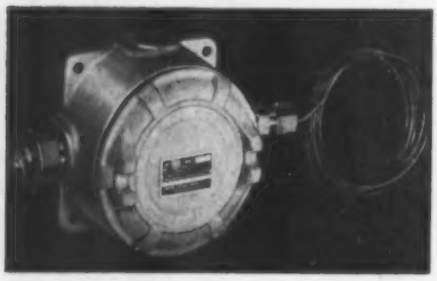
Even an inexperienced person can operate this leak detector since only a few connections place the instrument in the system and a few adjustments prepare it for use. Selection of sensitivity over six different ranges can be had for measuring almost any rate of leakage. Size of the leak also can be determined with the audio system when using a helium probe at a distance from the instrument. The pitch of the leakage warning signal changes roughly in proportion to the leak size.

The instrument is installed in a cabinet 43 inches high, 25 inches deep and 22 inches wide and mounted on ball-bearing rubber-tired casters. Electrical chassis are mounted on the back of the door which has a removable panel to permit entrance to the wiring of the chassis. Standard readily available electrical and vacuum system components are used. The equipment is operated from a standard 115-volt, 60-cycle lighting circuit. Literature on Model 24-101 Leak Detector is available on request.

CHECK THE CARD AT PAGE 232

7—Explosion Proof Thermostat

United Electric Controls Company, 69-71 A Street, Boston, announces a new remote-bulb thermostat designated the Type EJO. This new thermostat is a low-cost, explosion-proof control, especially designed for applications where dangerous dust and fumes are prevalent. All mechanism is located in an approved housing, the cover of which is threaded for easy removal for inspection or maintenance. This control may be mounted in any position on a flat surface. The housing is tapped, ready for installation of electrical connections.



United EJO Thermostat.

The Type EJO has an external calibrated adjustment with 120 degrees F or 250 degrees F range in models covering minus 120 degrees F to 600 degrees F. Four remote bulb styles are available. Electric ratings are as follows: AC 1200 watts, 115-230 colts noninductive; AC 300 watts, 115-230 volts inductive.

CHECK THE CARD AT PAGE 232

8—Refractories

George P. Reintjes Company, 2517 Jefferson Street, Kansas City, Missouri, has available its Catalog C-46, on Industrial Heat Enclosures. It is an extended and well illustrated discussion of furnace walls, and materials and methods used by this manufacturer.

CHECK THE CARD AT PAGE 232

9—Welded Motors

The Elliott Company, Jeannette, Pennsylvania, has announced a new steel fabricated motor line. Five frame diameters cover the range of standard ratings from 150 to 1000 horsepower and 4 to 14 poles. Special features claimed for the new line include extreme rigidity, lighter weight, lower space requirements, directed ventilation, and a number of points important from the maintenance standpoint.

Elliott "Fabri-Steel" Motor

The new Elliott "Fabri-Steel" motors are described in Elliott Company Bulletin L-12.

CHECK THE CARD AT PAGE 232

10—Thermometer

Accuracy Scientific Instrument Company, Philadelphia, is offering a separable socket industrial thermometer. This new development eliminates necessity of returning the thermometer to the factory for repairs, and makes it possible for the maintenance man to insert a new refill stem in a few minutes.

This thermometer is available in angle- and straight-stem types with heavy armor protection to resist corrosion and dirt. It is equipped with a flat-bore mercury stripe in a yellow column for easy reading.

Full details are included in Bulletin 55.

CHECK THE CARD AT PAGE 232

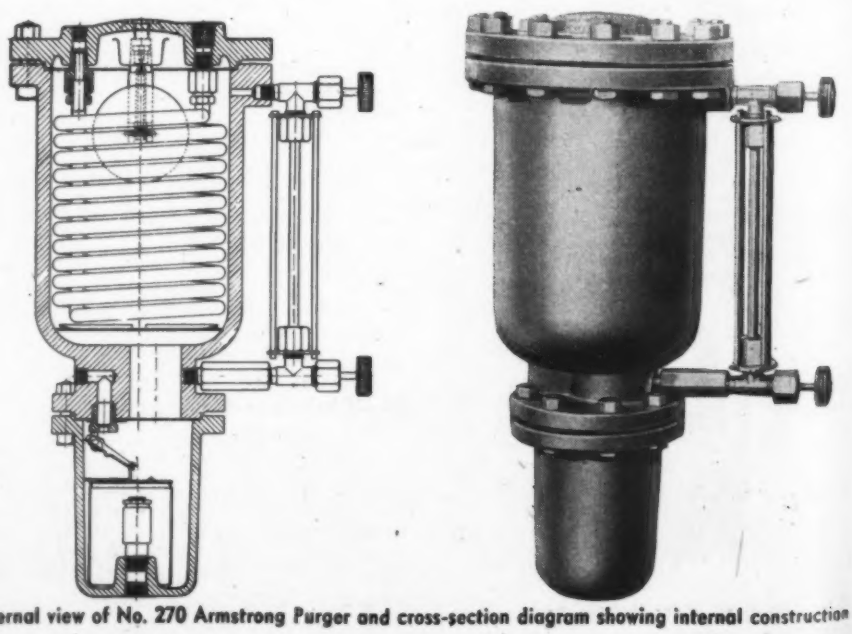
11—Refrigerating-System Purger

Armstrong Machine Works, 852 Maple Street, Three Rivers, Michigan, has recently introduced a new non-condensible gas purger for refrigerating systems which in service tests has operated at efficiencies ranging from 98 to 100 percent. Design is essentially the same as in older Armstrong models except that the refrigerating jacket has been replaced by an internal coil. Use of the coil increases by approximately 50 percent the condensing surface available for separating non-condensible gases from the refrigerant. In addition, the purger incorporates a new non-condensible gas-discharge mechanism in which the ball float used to actuate the valve has been enlarged and the valve itself improved.

The new Armstrong Purger is offered in two styles: No. 270 with semi-steel body for pressures up to 200 psi and No. 370 with forged-steel body for pressures up to 300 psi. Adaptable to systems of virtually any capacity, the purger operates with equal efficiency regardless of whether system pressure is above or below atmospheric.

The new purger is described in detail in Bulletin No. 173, which also contains a helpful discussion of the problems of removal of air and noncondensible gases from refrigerating systems.

For maximum efficiency, the refrigerant gas in a refrigerating system must be of high purity. Air or other noncondensible gases present in a refrigerant have the effect of increasing the amount of pressure that must be applied to make it condense into usable liquid form. To apply additional pressure requires use of extra power. The function of the purger is to automatically separate and discharge the non-condensible impurities. To do this, the purger is connected to draw gas from points where the impure gas tends to collect, such as in the high points of the condenser and receiver. This gas is fed into the liquid-filled interior of the purger through a small vent in the top of an inverted bucket. The liquid refrigerant in the purger is kept chilled by the evaporating coil contained in the upper chamber. Gas bubbling up from the inverted bucket is deflected by a baffle to strike



External view of No. 270 Armstrong Purger and cross-section diagram showing internal construction

CROLL-REYNOLDS EVACTORS

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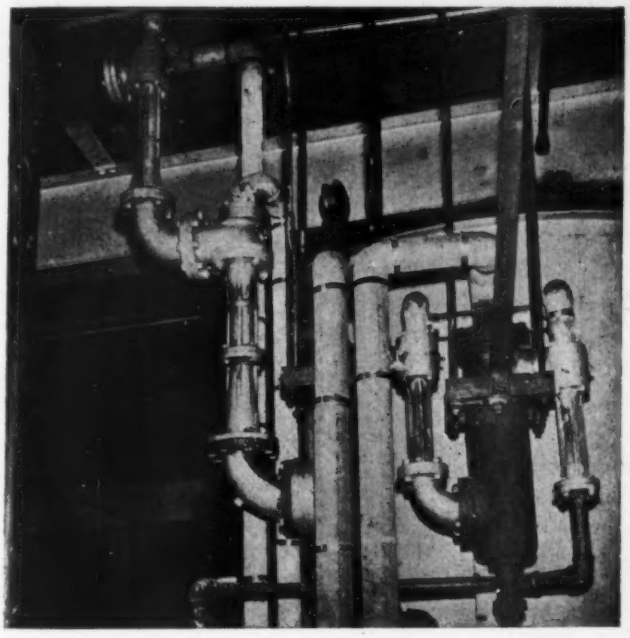
efficient

and

dependable

HIGH VACUUM

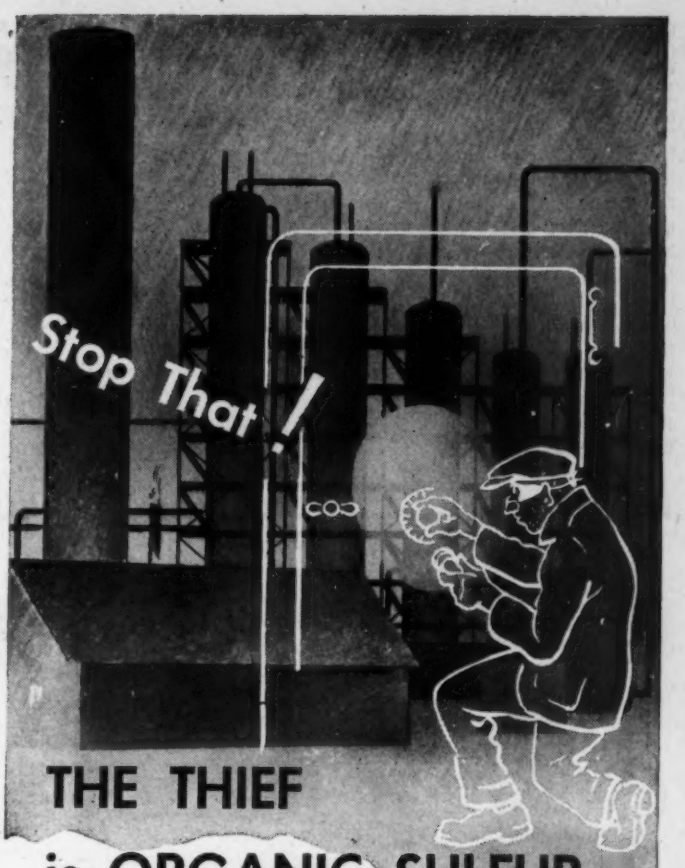


The above view shows an operating installation of a 4-stage Evactor serving a still handling a high boiling organic material at an absolute pressure of one tenth of 1 mm. In this plant, as in so many others using Croll-Reynolds Steam Jet Evactors, a duplicate installation was made when capacity had to be increased.

Evactors are available in single and multi-stage units of various types and are serving a wide variety of requirements in the petroleum and chemical industries, including vacuum refrigeration and vacuum cooled heat exchangers.

CROLL-REYNOLDS ENGINEERING CO.

17 JOHN STREET NEW YORK 7, N. Y.



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Catalytic removal of objectionable sulfur compounds has been found to work great improvement in the leaded octane numbers of most gasolines. At the same time, "sour" distillates are "sweetened."

FLOREX* and Florite*

are inexpensive natural catalysts which modern refiners use with the most satisfactory results in their desulfurization processes. Samples and technical data are available on request. Inquiries are welcomed.

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the cold coil. Portions that will not condense collect in the top and are released by a simple float-controlled needle valve. Excess liquid formed by the portions that condense is discharged (through the valve controlled by the inverted bucket) into the evaporation coil where it helps supply the chilling effect needed to operate the purger. This purging method is applicable to any of the commercial refrigerants, such as ammonia, freon, carbon dioxide, or sulfur dioxide, used in compression-type systems. One of the important advantages claimed for the new model is that it reduces loss of gas in purging to practically zero. In the petroleum and chemical industries, the purger has application in gas purification processes.

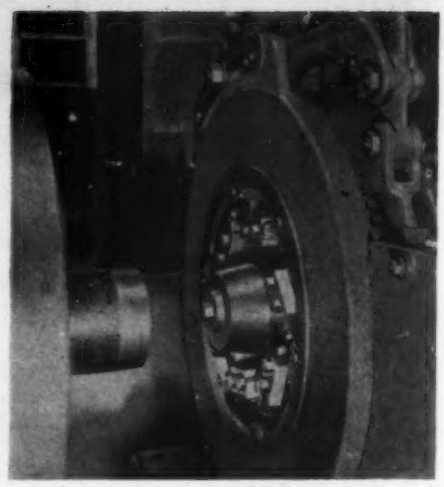
CHECK THE CARD AT PAGE 232

12—Centering Pilot for Threading and Cutting Off Machines

Landis Machine Company, Waynesboro, Pennsylvania, has developed a centering pilot designed for its 8⅝-inch and 13⅜-inch receding chaser pipe-threading-and-cutting-off machines.

The spring pilot is bolted onto the rear of the cross rail. Since this necessitates removal of the cutting-off slides, the machine is limited to threading only when equipped with the spring pilot.

Since the spring pilot forms a center in the bore of the die head for centering the pipe with the die head, only the rear chuck of the machine is used to grip the pipe during the threading operation. It is necessary that the front chuck clear the pipe by approximately ⅛-inch to permit the pilot to fully engage the bore of the pipe.



Landis Centering Pilot

In operation, the pilot is forced forward by a spring and engages the bore of the pipe prior to the pipe advancing to the chasers. The spring forces at the rear of the pilot are taken up by an anti-friction bearing. The 10-degree angle of the pilot permits its use on different wall thicknesses of pipe. When the pilot is changed for different diameters of pipe it is only necessary to remove one screw in the center of the pilot.

The principal advantage of the spring pilot is that it centers the pipe true with the die head, assuring concentric threads and permits of higher threading speed. Chatter is eliminated from the thread by the pilot and the chasers can be set further back of center, thus increasing the clearance back of the cutting edge. This setting of the chasers results in greatly increased tool life and materially improved thread finish.

CHECK THE CARD AT PAGE 232

13—Temperature Controller

Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, has announced its "Electromax," described as an inexpensive temperature controller which has high sensitivity and versatility, and needs practically no attention.

Especially designed for those applications where indicating and recording are not required, this instrument signals and controls only, although temperature readings can be taken manually with it at any time. The instrument consists of a Wheatstone-bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard types, require no matching, balancing or other

Leeds & Northrup "Electromax" Controller

Combines **THE BEST FEATURES OF A GATE VALVE AND A PLUG VALVE**

Wrench Operated

Worm Gear Operated

Wedgeplug Valves represent the first radical improvement in valve design in many a year—through the development of a simple, patented plug valve construction which incorporates wedging action and raised seats, with the advantages of a dry plug valve having large port openings; and, a simple, easy-to-operate mechanism that lifts, turns, and re-seats the plug in one operation.

Tried and proved! Write for Bulletin No. 545.

For Immediate Shipment: Some sizes of Wedgeplug Valves—ranging from 1" to 14", in both carbon steel and alloy—are available for immediate shipment from Factory Stock. Inquiries are invited!

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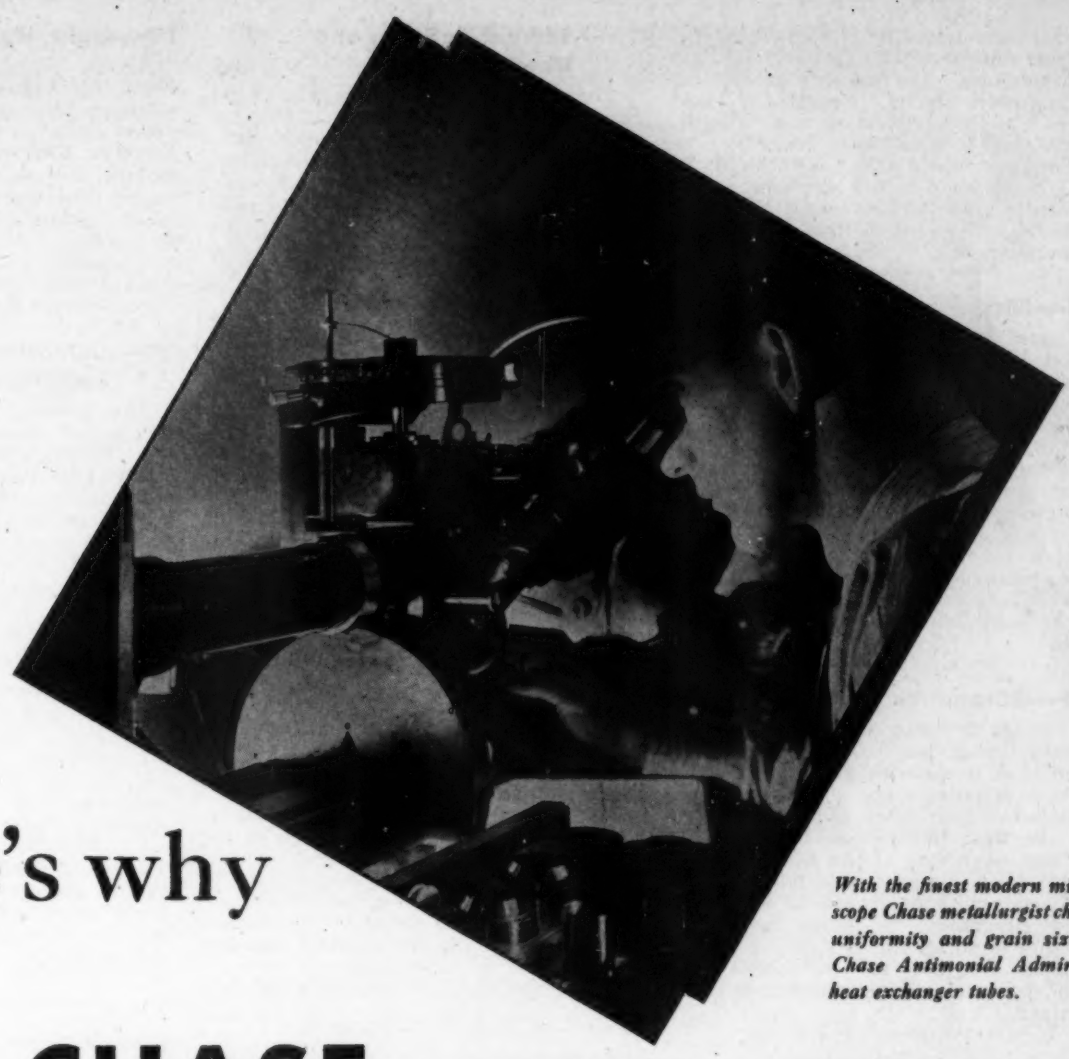

Here's why

With the finest modern microscope Chase metallurgist checks uniformity and grain size of Chase Antimonial Admiralty heat exchanger tubes.

CHASE ANTIMONIAL ADMIRALTY*

reduces annual replacement cost of heat transfer tubes . . .

YOU get longer service life from heat transfer tubes made with Antimonial Admiralty. That's because of the remarkable resistance of this patented Chase copper alloy to dezincification.

Millions of pounds of Antimonial Admiralty have been installed since Chase developed it in 1935. Scarcely a single service failure from dezincification has been reported. Oil refinery engineers can appreciate what a saving this represents in annual tube replacements.

You would expect to pay more, perhaps, for a heat transfer tube of such quality. Actually, the initial cost of Chase Antimonial Admiralty tubes is no greater than for plain Admiralty. For information phone the nearest Chase Warehouse or Service Office.

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Special stocks of
ANTIMONIAL ADMIRALTY
Condenser Tubes in Chase Warehouses
at
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SAN FRANCISCO
also carried by—
Vinson Supply Co., TULSA
Standard Brass & Mfg. Co.
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BRASS & COPPER CO.

Waterbury 91, Connecticut
SUBSIDIARY OF KENNECOTT COPPER CORPORATION

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special selection. It is a-c operated. Temperature-sensitive elements used are "Thermohms," the maker's resistance-thermometer bulbs. Length of lead wires not effect calibration, and "Thermohms" can be changed as desired.

The instrument case is 11-9/16 by 11-1/16 by 9-1/6 inches and can be conveniently mounted. Standard ranges are 0 to 250° F. and 0 to 1000° F., or corresponding °C.

CHECK THE CARD AT PAGE 232

14—Filters

Liquid Conditioning Corporation, 423 West 126th Street, New York 27, has released two bulletins which describe filters of various types. Bulletin 1 outlines many types of clarifying filters, and Bulletin 3 describes oil-removal filters recently placed on the market by this company. Bulletin 1 also explains design and applications of "Liquon" chemical feeders and the company's sludge contact reactor for coagulating and removing suspended impurities which occur in raw water in too great amount to be removed by direct filtration.

CHECK THE CARD AT PAGE 232

15—Rotameter Tube

Fischer & Porter Company, Hatboro, Pennsylvania, has issued Catalog Section 15-A to describe Bead-Guide Rotameter metering tube. This new tube eliminates float-guide rods, the guiding of the float being done by three ribs in the inner face of the glass metering tube. This permits selection of float materials without regard to drilling it, and eliminates the guide wire—both factors important in handling corrosive liquids. The new tube is applicable in modernization of instruments, it is explained.

CHECK THE CARD AT PAGE 232

16—Solvent Refining and Dewaxing

The Texas Company, 135 East 42nd Street, New York 17, has available for distribution copies of its technical publication, "Lubrication," for December, 1946, which contains a comprehensive article on "Solvent Refining and Dewaxing of Lubricating Oil." Illustrations include simplified flow diagrams of the Furfural Refining Process, and the Solvent Dewaxing Process.

CHECK THE CARD AT PAGE 232

17—Light Hydrocarbons

"Light Hydrocarbon Properties" is the title of a new handbook-style tabulation issued by Griffin Chemical Company, San Francisco.

The booklet presents, in tabular form, hydrocarbon and light petroleum liquid and gas properties, with thermal data and data on combustion. Blank columns are provided for insertion of additional data as they are developed.

CHECK THE CARD AT PAGE 232

18—Chemical Pumps

Ingersoll-Rand Company, 11 Broadway, New York 4, has issued a new bulletin, Form 7095, on chemical pumps. It is illustrated with exploded views and cross sectional drawings, and contains performance and dimensional tables. The pumps described are designed to handle many liquids and a wide range of capacities. Parts which come in contact with the liquid being pumped are of material suited to the service. The Cameron shaft seal is shown with illustrations to describe its construction and action, and a page illustrates and describes the "Leakollector" stuffing box gland.

CHECK THE CARD AT PAGE 232

19—Light Hydrocarbon Analysis

Burrell Technical Supply Company, 1942 Fifth Avenue, Pittsburgh 19, Pennsylvania, has available Bulletin 205, which discusses the Turner-Burrell Adsorption Fractionator for light-hydrocarbon analysis. It is described as a simply operated, self-contained unit which separates, identifies, measures, and collects the components of light-hydrocarbon gas mixtures and records the analytical data.

CHECK THE CARD AT PAGE 232

20—Corrosion Resisting Equipment

The Duriron Company, Dayton 1, Ohio, has issued its General Catalog H, which gives a general description of each type of corrosion-resisting equipment produced by the company, including pumps, valves, heat exchangers, pipe and fittings, mixing nozzles, steam jets, ejectors, tank outlets, kettles, tanks, exhaust fans, sinks, bowls, strainers, traps, etc.

CHECK THE CARD AT PAGE 232

21—Chemical Pumps

Milton Roy Pumps, 1300 East Mermaid Avenue, Chestnut Hill, Philadelphia 18, has issued a new Catalog No. 142, descriptive of its controlled-volume and high-pressure pumps. Illustrations include cutaway drawings showing construction details. Tables show capacities—1 pint per hour to 46 gallons per minute, and pressures—up to 20,000 pounds per square inch. Color charts for selection of materials of construction for specific services should prove of value not only for pumps but for other equipment in chemical service.

CHECK THE CARD AT PAGE 232

22—Automatic Controls

General Controls Company, 801 Allen Avenue, Glendale, California, has issued Catalog 52C, pictorially illustrating its line of automatic pressure, temperature and flow controls.

CHECK THE CARD AT PAGE 232

23—Connections and Openings

Lenape Hydraulic Pressing and Forging Company, Box 536, West Chester, Pennsylvania, has a new folder, Bulletin 4-61, illustrating its line of connections and openings for pressure vessels.

CHECK THE CARD AT PAGE 232

24—Stud Welding

Nelson Sales Corporation, Lorain, Ohio, has published a stud-welding data book and catalog designed to provide factual information on the use of automatic stud welding. Information on designing for stud welding is given, together with specifications and physical properties data on Nelson flux-filled studs.

CHECK THE CARD AT PAGE 232

25—Water Valves

Golden-Anderson Valve Specialty Company, Keenan Building, Pittsburgh 22, has issued a new four-page bulletin which includes illustrated descriptions of its water-pressure-reducing valves for use where uniform downstream pressure against a higher inlet head is required; valves designed to maintain uniform water level in tanks or reservoirs, and other special items.

CHECK THE CARD AT PAGE 232

Spiral Rings

"U. S. Stoneware" CYCLOHELIX Spiral Rings are made from the finest chemical stoneware clay bodies available. They are acid-and-corrosion proof throughout whether glazed or unglazed. CYCLOHELIX Spiral Rings are virtually indestructible.

CYCLOHELIX Spiral Rings are made in 3¼", 4" and 6" O.D. sizes in single, double and triple spiral types, glazed or unglazed, and in standard or Ceratherm-500 heat-shock resistant bodies.

CYCLOHELIX Spiral Rings are only one of some 15 different styles of Tower Packing we manufacture, each designed for a specific use.

Write for Free Book showing our complete line of TOWER PACKING and filled with helpful information. Ask for Bulletin 52 PR.

U. S. STONEWARE
Akron 9, Ohio

26—Pressure Reducing Valves

Leslie Company, Lyndhurst, New Jersey, has issued Bulletin 461, which gives engineering, operating and maintenance data on pressure-reducing valves, differential valves and over-flow valves for steam, air or gas service. Recommended installations are shown and discussed for remotely adjusted valves, valves with external ports, and valves designed for external control. Approved methods of grinding main valves, tightening controlling valve seats and checking controlling valve-stem clearance are described pictorially, with information for dismantling, cleaning and assembling.

CHECK THE CARD AT PAGE 232

27—Separators

Selas Corporation of America, Erie Avenue and D Street, Philadelphia 34, has published an illustrated folder which describes a new unit for phase separation of immiscible liquids.

CHECK THE CARD AT PAGE 232

28—Portable Pyrometers

Wheelco Instruments Company, 847 West Harrison Street, Chicago 7, has available Bulletin D602-4, which describes the company's line of portable pyrometers. Specifications for selection of extension holders, adapters and thermocouple tips are listed in chart form.

CHECK THE CARD AT PAGE 232

29—Eye Safety

American Optical Company, Southbridge, Massachusetts, has available a new eye-safety guide which lists industrial eye hazards by industries and recommends proper protection equipment.

CHECK THE CARD AT PAGE 232

30—Cutting Stainless and Alloy Steels

Arcos Corporation, 1515 Locust Street, Philadelphia 2, has available literature descriptive of a new method it has developed for hand cutting or piercing stainless and stainless clad, alloy steel, aluminum, bronzes and brasses, cast iron, Monel, Iconel and nickel. The process—known as the Arcos Oxyarc Process—achieves the cutting by the combination of an electric arc and a stream of oxygen. The equipment consists of a specially designed holder, and a tubular coated rod which is consumed in the process of cutting.

CHECK THE CARD AT PAGE 232

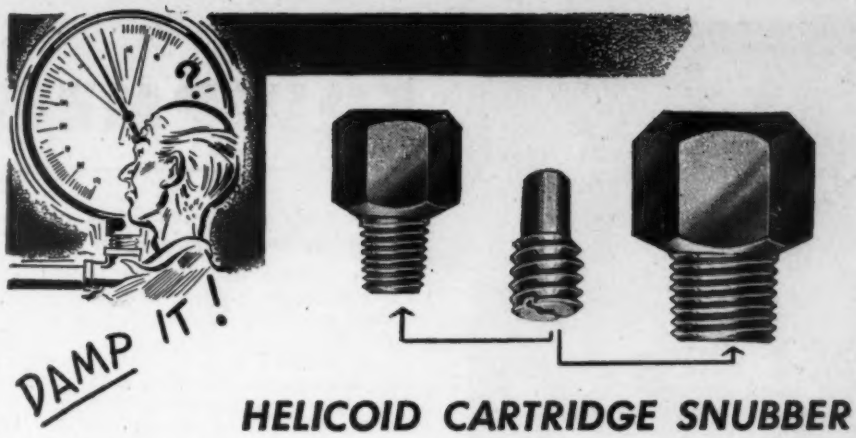
31—Silicon Alloy

The Babcock & Wilcox Tube Company, 85 Liberty Street, New York 6, has announced development of a modified type of 18-8 silicon alloy, designated Croloy 18-8 Si., which shows promise for certain parts of equipment used in dehydrogenation of petroleum fractions in the synthetic rubber industry.

H. D. Newell, chief metallurgist, said that this alloy retains ductile properties on long heating and is relatively inert chemically under alternating reducing and oxidizing conditions.

"It is presently to be used as a substitute for Croloy 27 (27 percent chromium-iron) in a plant producing butadiene from butane by the dehydrogenation process. Other uses involving greater oxidation resistance or enhanced surface stability are expected, as the alloy will undoubtedly give economical performance in comparison with placing ordinary 18-8 alloy in certain types of service. The present use for this alloy was developed after long time exposure tests under full operating plant conditions.

CHECK THE CARD AT PAGE 232



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PRESSURE GAGE SNUBBERS

... for use where pulsations of gage pointer make accurate reading difficult or impossible. Damping action assured by porous cartridge of compressed, powdered bronze, threaded into gage socket or into snubber body. No adjustments ever needed. Specific porosity of cartridge makes it effective for required service – air, gas, water, steam or oil. Available for all pressures up to 10,000 pounds. May be supplied with Helicoid Gages or bought separately for use with other gages.

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A DIFFERENT KIND OF PRESSURE GAGE

The unique design of the Helicoid movement – with cam and helical roller instead of gears – obsoletes conventional type pressure gages. A Helicoid Gage will maintain its guaranteed accuracy longer – a fact proved in thousands of installations. For complete information, write for our Catalog DH-818.

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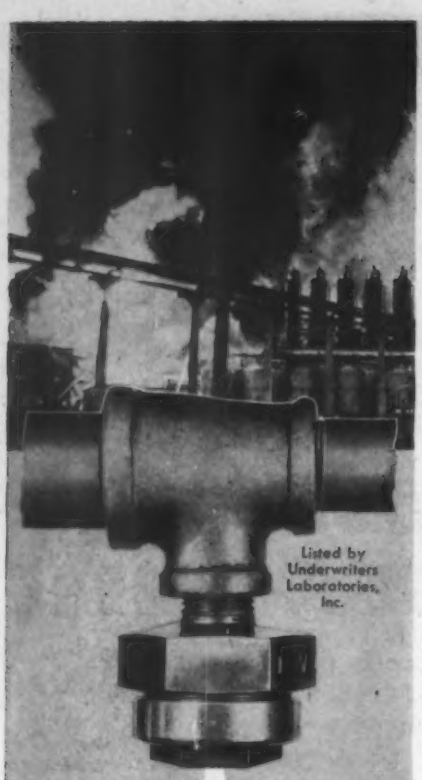

WHERE HAZARDS ARE GREAT

Wherever an industry requires the storage or handling of materials capable of bursting instantaneously into an intense and devastating fire, the utmost in fire protection is none too good.

Blaw-Knox Aquatomic Fog Nozzles stop "bad fires" at the start.

These dependable non-clogging and hard hitting sprinkler heads cool and quench sudden fires in mere seconds.

Install Aquatomic Nozzles 100% on your fixed sprinkler system for 100% dependable protection.

Also—

Blaw-Knox offers Standard Wet and Dry Pipe Systems, as well as Thermostatically Controlled Pre-Action and Deluge Systems.

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About EQUIPMENT—SERVICE Suppliers

Equipment Suppliers Association San Francisco Convention Dates

The annual membership meeting of the Petroleum Equipment Suppliers Association will be held at the Mark Hopkins Hotel, San Francisco, May 4-7, H. R. Safford, Jr., executive secretary, has announced. Registration is planned May 4, whereas business and social activities will fill the other three days.

Bridgeport Brass Company Names Houston Representative

George C. Chatneuff, recently of the company's St. Louis office, has been made manager for Bridgeport Brass Company at Houston, where he will have headquarters at 2216 Walker Avenue. Chatneuff succeeds Thad Smith, Jr., who resigned to take up activities in another field.

Condenser Engineering Company Names Flesher Sales Manager

Carl W. Flesher has been made sales manager of Condenser Service & Engineering Company, Hoboken, New Jersey.

Flesher graduated from the United States Naval Academy in 1927, after which he served three years at sea before joining the marine sales department of Westinghouse Electric Corporation. In 1938 he became associated with the Maritime Commission in Washington, and in 1942 was transferred to Oakland where he was in charge of the commission's shipbuilding program on the Pacific Coast throughout the war.

Organization Will Apply Fluid Catalysis to Chemical Industry

The Marshall-Moorman Development Company has been organized as a partnership to offer a consulting and process engineering service to the petroleum and chemical industries on specific new applications of the fluid catalyst technique. Walton H. Marshall, Jr., and Joseph W. Moorman, both formerly with The M. W. Kellogg Company, are the organizers, with offices at 19 Rector Street.

Marshall received a B.S. in chemical engineering from Massachusetts Institute of Technology in 1935. He was employed by The Kellogg Company from that time until October, 1946, with the exception of 3½ years in the Navy, from which he was discharged with the rank of lieutenant commander. As process engineer with Kellogg, Marshall assisted in development of thermal and catalytic polymerization processes and was in charge of process design of the Dixie Ordnance Works plant at Sterlington, Louisiana, and the plant at Lake Charles, operated by the Mathieson Alkali Works. Both were synthetic ammonia plants manufacturing low-cost fixed nitrogen from natural gas. He was also Kellogg's process engineer for a 100-octane gasoline hydrogenation unit of the Standard Oil Company (Indiana) and of a similar unit for Lago Oil and Transport Company at Aruba.

Moorman is a graduate of the University of Tulsa, from which he received his B.S. in petroleum engineering in 1935. He joined Kellogg in 1937, after spending two years in general construction work. His assignments as a process engineer with Kellogg have been primarily on catalytic cracking since 1938. He took part in designing the initial fluid unit developed and constructed by that company and has worked on the designs and operations of many subsequent installations. During the war much of his time was spent in the field, solving practical operating problems and training operators of these units.

J. W. Moorman

W. H. Marshall, Jr.

Davison Chemical Corporation Makes Executive Changes

The Davison Chemical Corporation, Baltimore, Maryland, has announced an expansion of its official organization through promotion of two men within the organization, and election of two new officers from outside.

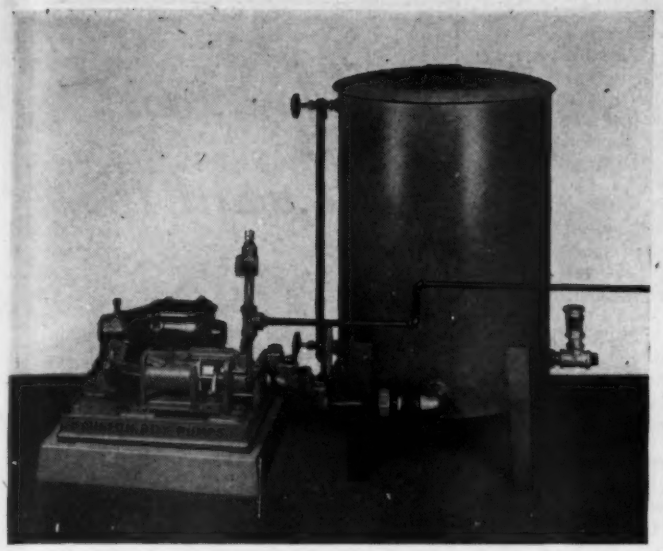
E. B. Dunkak

Marlin G. Geiger has been elected to the new position of executive vice president; Elmer B. Dunkak has been promoted to vice president; Dr. G. Miller Hebbard has been elected vice president in charge of operations, and Dr. Charles E. Waring has been promoted to vice president for research and development.

Geiger graduated with a B.S. in industrial chemistry from Pennsylvania State College, and joined Westvaco Chlorine Products Company in 1925, and has been vice president of that company since 1940. He also is vice president and director of United Chemical Corporation and president of West Virginia Charcoal Company.

Dunkak is a chemical-engineering graduate of Pratt Institute and took graduate work at Brooklyn Polytechnic and at Massachusetts Institute of Technology. He jointed The Davison Chemical Corporation in 1944 to organize the process division. In 1945 his duties were increased to include all engineering activities.

Dr. Hebbard graduated from Lehigh University in 1929, and subsequently took his master's degree in chemistry and his doctor of science degree in chemical engineering at University of Michigan. He comes to his present position from the Office of Rubber Reserve,

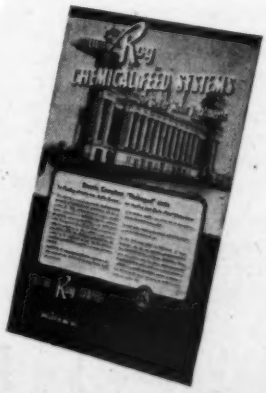


MILTON ROY
CHEMICAL FEED SYSTEMS
for Boiler Water Treatments

Authorities agree two distinct methods are necessary for chemically treating boiler water. Sodium Sulfite should be fed into the suction side of the feed water pump . . . to remove dissolved oxygen, insure against corrosion and prevent pitting. Other treating chemicals, such as phosphates, soda ash and caustics cannot usually be fed in this manner. Individual chemical feed directly into each boiler is the approved method . . . to prevent scale formation, control alkalinity and prevent embrittlement.

Milton Roy "Packaged Units" are available for both treating methods. For internal treating the unit includes heavy gage welded steel tank, gage glass, low level pump cut-out and alarm, together with necessary pump or pumps. For sulfite feed the unit includes 50 gal. 12 gage welded tank, gage glass, low level pump cut-out, bell alarm, doughnut float and one Milton Roy Pump with screw adjustment of stroke.

These "Packaged Units" are available also with electronic control, to continuously operate at a speed proportional to the rate of feed water flow as measured by a standard type flow meter. Fully automatic control is thus obtained, treatments are precisely as required, waste of chemicals is avoided.



For complete description of these systems, with specifications, diagrams, selection tables, etc., write for Bulletin 451. If interested in automatic controls, ask also for Bulletin 468.

MILTON Roy COMPANY
1383 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

HERE'S good news for users and prospective users of furfural and its derivatives. On November 1, 1946, The Quaker Oats Company purchased the furfural manufacturing plant at Memphis, Tenn., formerly owned by the government. This plant, operated for the government during the war by The Q. O. Chemical Company, a wholly owned subsidiary of The Quaker Oats Company, supplied all the furfural requirements for the government's vast synthetic rubber program. Now, this same personnel continues under the new ownership to run this plant, government needs being supplied from here as before.

TWO SOURCES FOR INDUSTRIAL USERS

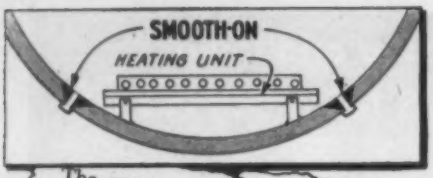
Excess capacity from the Memphis plant, the largest furfural producer in the world, as well as the entire facilities at the Cedar Rapids plant, are now available to industrial users of furfural and its derivatives.
With these two sources, widely separated geographically, users of furfural are further assured of an uninterrupted flow of furfural in ample volume to meet their needs.

FURFURAL'S VERSATILITY WARRANTS YOUR INVESTIGATION

This versatile aldehyde, the cheapest pure aldehyde available today, is rapidly growing in importance in a wide variety of applications. If you are not entirely familiar with its current uses and reactions, we suggest you write on your letterhead for literature we have available.

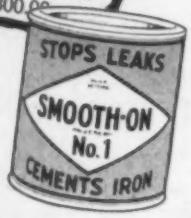
The Quaker Oats Company CHEMICALS DEPT.

1850 BOARD OF TRADE BLDG.
141 W. JACKSON BLVD., CHICAGO 4, ILLINOIS
In the United Kingdom, Quaker Oats Ltd., Southall, Middlesex, England
In Europe, Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands
In Australia, Swift & Company, Pty. Ltd., Sydney
Furfural • Furfuryl Alcohol • Furoic Acid • Tetrahydrofurfuryl Alcohol



The worn sections were drilled and tapped for ⅜ in. bolts and cemented in with Smooth-On. This produced a pressure-tight plug for the hole and took only a little time and involved little or no cost, except for the labor required to drill the holes and insert the bolts. Compare this with the $2,800 pe

(Clipping from *National Engineer*, Nov. 1943)



$2800 SAVED

by using a little SMOOTH-ON No. 1

After years of service a 20,000-gallon fuel oil tank developed a leak, due to a hole caused by movement of the heating element.

Remedy was simple. The hole and another incipient hole were drilled and plugged with bolts cemented in with Smooth-On No. 1, the worn spots also filled in with additional Smooth-On; and the tank was ready for many more years of service, as reported in National Engineer (See clipping reproduced above).

This Smooth-On No. 1 repair at infinitesimal cost, saved a $2800 expenditure for a new tank. No heat required, no serious dismantling, no delay, small labor expense.

For half a century, Smooth-On has been used for stopping leaks, sealing cracks, tightening loose parts effectively, lastingly. Keep a can handy for both emergency and routine repairs. In 1-, 5-, 25- and 100-lb. sizes at your supply house, or if necessary, direct from us.

FREE

VALUABLE REPAIR HANDBOOK

40 pages. 170 diagrams. Clear, concise, tested directions for ingenious repairs to plant equipment, structures, pipe lines, etc. Pocket size. Handy index. Just send coupon.

——— MAIL THIS TODAY ———

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570 Communipaw Ave., Jersey City 4, N. J.
Please send SMOOTH-ON HANDBOOK

Name .....

Address .....

2-46 .....

Do it with
SMOOTH-ON
Iron Cement of 1000 Uses

with which he has served as deputy director of production, research and development, with full responsibility for direction of the government's activities in synthetic-rubber production and development. Previously he had served as technical adviser to the president of Southern California Gas Company, and had been ten years with The Dow Chemical Company, with which he rose to executive assistant to the president as a liaison engineer for the engineering and construction of magnesium plants and foundries for Defense Plant Corporation.

Dr. Waring is a graduate of Ohio Wesleyan and Ohio State Universities. During the war he was consultant to the Army on packaging, and served as a member of the tropical deterioration committee of the Office of Scientific Research and Development. Previously he had done research work on refrigerants, oil, plastics and corrosion-preventive methods for Frigidaire Division of General Motors Corporation, and had been with the Eastman Kodak Company research laboratory.

Williams Heads Worthington Foreign Business Department

S. Riley Williams has been elected vice president in charge of foreign business president in charge of foreign business for Worthington Pump and Machinery Corporation. In his new capacity he will have responsibility for the sale of Worthington products for export, as well as administration of Worthington associated companies in South America and Europe.

S. R. Williams

Williams joined the Worthington organization in 1920, after service in the first world war as an Army lieutenant. From 1920 until 1941 he resided in Europe, where he successively was managing director of the Worthington company in Spain, in France, and general European manager. In 1941 he returned to the United States, and served as assistant to the vice president in charge of operations. In May 1945 he was appointed director of international business.

Bechtel Corporation Succeeds Bechtel Brothers McCone Co.

Effective January 1, the name of Bechtel Brothers McCone Company, was changed to Bechtel Corporation. At the same time, three subsidiaries became respectively Bechtel International Corporation; Compania Bechtel, S. A., and International Bechtel, Inc.

The change was made, it was announced, in the interest of simplification and convenience. The organization's policies and the scope of its services as engineers and constructors will remain as in the past.

Principal officers are S. D. Bechtel, president; W. E. Waste, Van W. Rosendahl, J. Perry Yates, V. G. Hindmarsh, Jerome K. Doolan, and C. Stribling Snodgrass, vice presidents. Executives and key personnel have been closely associated for many years in the extensive activities of the Bechtel interests. Headquarters and major engineering offices

You, too, will want the

1947 PROCESS HANDBOOK

Now being compiled, the Process Handbook will be sent to all Petroleum Refiner subscribers (old and new) whose subscriptions are in force when the Handbook is published as the second volume of a forthcoming issue.

The PROCESS HANDBOOK will cover all major processes used in the refining and natural gasoline industry.

The PROCESS HANDBOOK will present over 90 processes in explanatory text with accompanying flow sheets.

The PROCESS HANDBOOK will describe all important new refining processes and improvements developed during the war.

The PROCESS HANDBOOK will include all of the important processes available for license which are used in processing crude petroleum and natural gas.

You'll want to have your own personal copy of this valuable reference volume, so . . .

If you are not a subscriber or if your subscription is about to expire, use the coupon on page 209 and assure yourself of the practical, on-the-job help to be found in the Process Handbook and in every issue of Petroleum Refiner.

SEE PAGE 209

PETROLEUM REFINER

P. O. Box 2608 Houston 1, Texas

General Chemical Research Presents

genetron* 101

—second in its new series of ALIPHATIC ORGANIC FLUORINE COMPOUNDS

Out of General Chemical's extensive fluorine research program in the field of organic chemistry comes *Genetron 101* . . . the second in a series of important aliphatic organic fluorine compounds.

This chlorinated derivative of ethylidine fluoride has a lower melting point and lower vapor pressures than the parent compound. Many of its applications are already under investigation by far-sighted manufacturers who recognize the industrial potentialities of *Genetron 101:* as a refrigerant . . . an aerosol dispersant in admixture with other Genetrons . . . a selective solvent . . . a dielectric . . . and as an intermediate in the preparation of various other organic chemicals.

The physical data here may suggest uses for this low boiling organic liquid which also merit your prompt investigation. For experimental samples, write General Chemical Company, Fluorine Division, 40 Rector Street, New York 6, N. Y.

*Trade Mark, General Chemical Company

genetron* 101
PHYSICAL PROPERTIES

Formula	$CH_3 \cdot CClF_2$
Molecular Weight	100.51
Color	Colorless
Melting Point	—130.8° C
Boiling Point	—9.2° C
Density	1.194 at —10° C
Latent heat of vaporization	96 B.t.u./lb.

Vapor pressure (p.s.i. abs.):

—30° C	6.0
—10° C	14.7
10° C	31.2
30° C	59.0

BASIC CHEMICALS

GENERAL CHEMICAL COMPANY

FOR AMERICAN INDUSTRY

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Sales and Technical Service Offices: Albany • Atlanta • Baltimore • Birmingham • Boston Bridgeport • Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Houston Kansas City • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh Providence • San Francisco • Seattle • St. Louis • Wenatchee and Yakima (Wash.)

In Wisconsin: General Chemical Wisconsin Corporation, Milwaukee, Wis.

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

WATER
MEANS A LOT
TO CITIES LIKE SIOUX FALLS, S. D.

Sioux Falls, S. D., is a typical American City. Like many other smaller towns, it is growing into a much more important distribution and manufacturing point. Water for further growth was needed in large—but economical quantities. The choice was a Layne Well Water System that is now producing a million gallons daily.

Sioux Falls is not burdened by high operation cost, and furthermore there will be very little—or perhaps no repair expense for years to come.

Layne Well Water Systems, used and famous the world over, are engineered for heavier duty than ever called upon to perform. Such extra ruggedness and remarkably fine quality makes them an unmatched investment for any city or industry. These Well Water Systems are built in a wide range of capacities suitable for present needs and future growth. Space requirements are small and installations can be completed in a matter of weeks.

For further information, literature, etc., address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

HIGHEST EFFICIENCY

Layne Vertical Turbine pumps are available in sizes to produce from 40 to 16,000 gallons of water per minute. High efficiency saves hundreds of dollars on power cost per year.

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. * Layne-Atlantic Co., Norfolk, Va. * Layne-Central Co., Memphis, Tenn. * Layne-Northern Co., Mishawaka, Ind. * Layne-Louisiana Co., Lake Charles, La. * Louisiana Well Co., Monroe, La. * Layne-New York Co., New York City * Layne-Northwest Co., Milwaukee, Wis. * Layne-Ohio Co., Columbus, Ohio * Layne-Pacific, Inc., Seattle, Wash. * Layne-Texas Co., Houston, Texas * Layne-Western Co., Kansas City, Mo. * Layne-Western Co. of Minnesota, Minneapolis, Minn. * International Water Supply Ltd., London, Ontario, Canada * Layne-Hispano Americana, S. A., Mexico, D. F.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

are located in San Francisco. An engineering staff is also maintained in Los Angeles, and elsewhere on the basis of projects under construction.

Brown Promotes Schmitt, Pyle and Roat to New Posts

Henry M. Schmitt has been named chemical industry manager of Brown Instrument Company, Philadelphia. O. B. Pyle has been made industrial manager of the Philadelphia branch and A. W. Roat is now industrial manager of the St. Louis branch of the industrial division of Minneapolis-Honeywell Regulator Company.

I. K. Farley has been placed in charge of the major petroleum accounts in the Philadelphia area and Harry D. Ruch will also work out of the industrial sales division at Philadelphia.

Schmitt has been with the company for the past 22 years, and Pyle 18 years.

Roat succeeds to the position held in the recent past by V. H. Hiermeier who has been transferred to the Honeywell international division, for assignment to a foreign post. Roat has been with the company nine years during which time he has served in Pittsburgh, Cleveland and Philadelphia.

Leeds & Northrup Given Public Relations Award

Leeds & Northup Company Philadelphia, was given the first annual industrial relations award of the Philadelphia Chamber of Commerce and Board of Trade. The award, a silver plaque, was made by William L. Batt, president of SKF Industries, to Charles S. Redding, president of Leeds & Northrup.

It was revealed that the award committee's attention was drawn to Leeds & Northrup by a dinner which the company gave on November 16, when 2,000 employes were given a detailed recital of the company's finances for the last fiscal year, including distribution of profits.

George L. Gudenrath Joins Delta Engineering Corporation

George L. Gudenrath has joined Delta Engineering Corporation, Houston, as vice president in charge of natural gas-gasoline process engineering. A graduate of Rice Institute in 1932 with a B.S. in chemical engineering, Gudenrath completed a year of graduate work before entering service with Shell Oil Company in research, technological work, and plant operations supervision. He later engaged in process design and operational problems for Hudson Engineering Corporation from 1940 to 1946.

Other officers of the corporation are Robert B. Baldwin, president; Allen R. Salley, vice president, and W. J. Geiselman, secretary-treasurer. Chief activity of the organization, from its offices at 1616 Bell Avenue, is design and construction of gas-processing facilities.

MacNeil Joins Tube Turns Chicago Sales Staff

Donald A. MacNeil has joined the sales staff of the forging division of Tube Turns (Inc.), Louisville, Kentucky, it is announced by John G. Seiler, vice president and general sales manager. He will make his headquarters at 327 South LaSalle Street, Chicago.

D. A. MacNeil

MacNeil was associated with the Kelly Steel Works, Inc., Chicago, for 16 years before resigning the vice presidency of that organization to join Tube Turns (Inc.).

Reed Joins Dallas Tank As Executive Assistant

Malcolm V. Reed has accepted appointment as assistant to W. W. Banks, president of Dallas Tank Company, Dallas, Texas. His duties will be of a general administrative type, it was said.

M. V. Reed

Reed has been head of the engineering and planning department of Wyatt Metal & Boiler Works at Houston and Dallas for the past 15 years.

Thomas C. Wilson, Inc., Names San Francisco Representative

Harang Engineering Company, 840 Lake Street, San Francisco, has been named Northern California representative of Thomas C. Wilson, Inc., Long Island City, New York, tube cleaner manufacturer. Edward A. Harang, who heads the company bearing his name, has degrees in chemical and mechanical engineering from University of Michigan, and has had contact with the power industry during the past ten years.

Fairbanks-Morse Announces New Manager for Chicago Branch

Fairbanks, Morse & Company has announced appointment of John S. King as manager of the Chicago branch of the company, succeeding Frank V. Roy who retires from that position which he has long held, on March 1. Roy joined the organization in 1908, and has served in a number of executive positions with the company.

King started with the company as a student in the Beloit plant where he as-

G. L. Gudenrath

R. B. Baldwin

A. R. Salley

W. J. Geiselman

DEAN BROTHERS PUMPS INC. INDEANAPOLIS, INDEANA. PUMPING MACHINERY

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

PUMPS

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL

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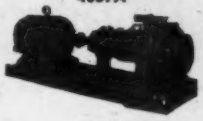

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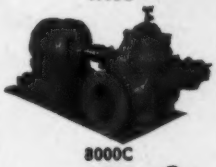

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RECIPROCATING

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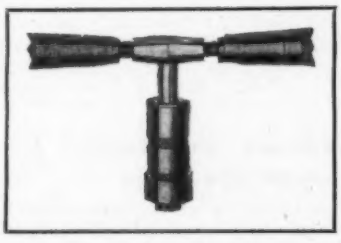
BRANCH OFFICES

NEW YORK HOUSTON

TITAN-KIRKLAND COMBINATION STUD DRIVER AND PULLER . . .



● Incorporates roll action to GRIP as little as 1/2" of unthreaded body of stud.

This stud setting tool requires only a slight left or right hand turn to effect a grip on the stud. When the chuck of the tool is lowered over a stud, the upper end of the stud contacts an adjustable stop screw. This automatically elevates the core and brings the rolls into centralized contact to the cam surfaces in the driving member and the stud. When rotation is stopped, the tool may be lifted off the stud without reversing the direction of rotation.

Made in T-Handle, Ratchet, and Power styles; in standard sizes from 3/16" to 1" inclusive. Larger sizes on request.

WRITE FOR LITERATURE TODAY

TITAN TOOLS

TITAN TOOL CO.

Production Tools

FAIRVIEW, PA.

This flow rate meter

ELIMINATES

"Bubble Counting"

THIS compact rotameter is the answer to purge line (Bubbler) control installation.

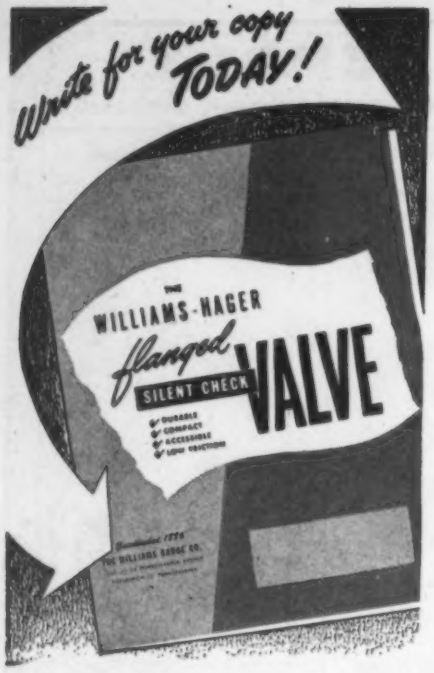
- no bubble counting
- true purge rate indication
- easily and neatly panel mounted singly or in multiple, requires a minimum of space
- furnished with or without needle control valve
- $9.00 per unit without control valve (lower price when purchased in quantity)

For complete specifications write for catalog 31-E.

DEPT. 5—1C

FISCHER & PORTER CO.

HATBORO, PA.

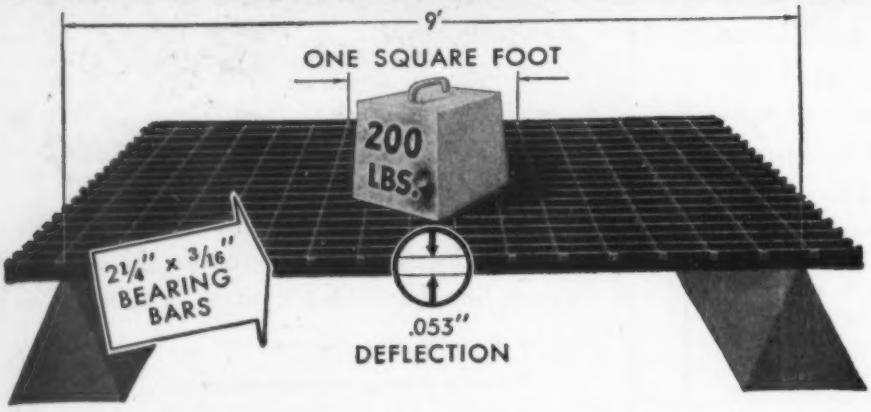


HAS "WATER HAMMER" BEEN A PROBLEM IN YOUR PLANT?

This new bulletin completely describes the Williams-Hager Flanged Silent Check Valve—designed to meet this problem and one of the most important developments in Check Valve design. Thoroughly tested in every industry, for every type of service—with many installations serving trouble-free for upwards of 18 years.

THE WILLIAMS *Gauge* COMPANY
2925 PENNSYLVANIA AVENUE
PITTSBURGH 12, PENNA.

This is **TRI-LOK**
OPEN STEEL FLOORING



The locked in strength of TRI-LOK enables it to stand up under heavy loads—even on long spans. No rivets, bolts or welds are used in its construction, thus, the possibility of loose joints is eliminated. *Write for Bulletin 1140.*

DRAVO CORPORATION
NATIONAL DEPARTMENT
300 Penn Avenue, Pittsburgh 22, Pa.
(Distributor for THE TRI-LOK COMPANY)

DRAVO

sembled and tested pumping equipment and diesel engines. In 1921 he was transferred to the Indianapolis Works of the company, building electric motors and generators. A year later he joined the sales force of the Chicago branch, working as territorial representative on pumping equipment until, in 1930, he was made manager of the pump department of that branch. In 1937 he was appointed manager of the firm's New Orleans branch. In 1945 he was recalled to the executive staff at Chicago where he was successively manager of the pump division and assistant manager of the railroad division which latter position he fulfilled until his present appointment.

Knoll Joins Republic Supply Company at Bartlesville

Carl L. Knoll has been appointed sales representative for Republic Supply Company, and will have his headquarters at the company's offices in Bartlesville, Oklahoma. He will work the northern Oklahoma and southeastern Kansas territory from this point, which is under general supervision of J. H. Brooks, vice president and district manager with headquarters at Tulsa.

Carl L. Knoll

Kroll has lived in Bartlesville for a number of years, and has been engaged in the oil-country supply business since 1920.

Limex Corporation Formed To Handle Water Treating

Lurie Laboratories, Indianapolis, Indiana, manufacturer of the "Limex" water treatment system, has announced formation of Limex Corporation to handle manufacture and sale of the water system treatment. Personnel, sales and service policy of the new corporation remains the same as the department which has been handling these activities, is was said.

Ladish Drops "Drop Forge" From Corporate Name

Ladish Drop Forge Company, Cudahy, Wisconsin, has changed its corporate name to Ladish Company. For more than 40 years the company has been one of the larger producers of steel and alloy forgings, and it has felt for some time, it was said in the announcement, that inclusion of "drop forge" in the company name may have implied a limitation of products to many people, particularly users of forged and seamless welding pipe fittings, of which the company is an important producer. It was emphasized that no change has been made either in the company's organization or policies.

Republic Flow Meters Makes Two Appointments

Republic Flow Meters Company, Chicago, has announced appointment of Christian W. Marks as manager of its Cleveland district office, and Eugene N. Davidson as manager of its St. Louis district office.

Marks is a mechanical-engineering graduate of Illinois Institute of Tech-

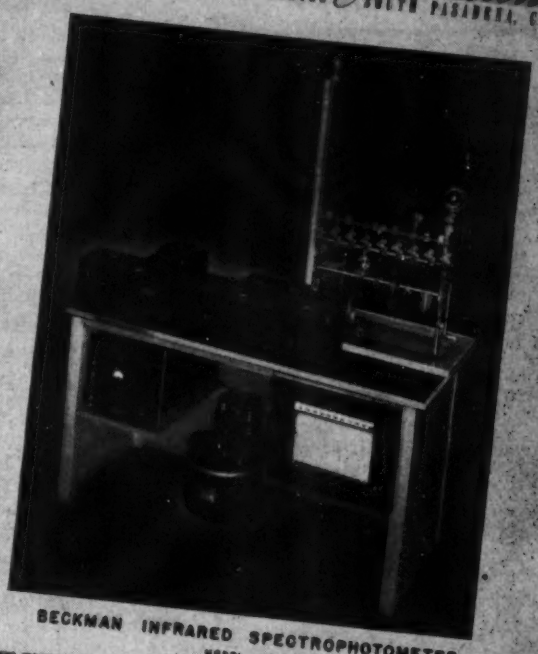
NEW!

. . . a 12 page bulletin fully describing the many outstanding features of the

BECKMAN IR2 INFRARED SPECTROPHOTOMETER

SEND FOR YOUR FREE COPY!

BECKMAN ... TECHNICAL LABORATORIES Bulletin 153 SOUTH PASADENA, CALIFORNIA



BECKMAN INFRARED SPECTROPHOTOMETER
MODEL IR2

THE BECKMAN IR2 INFRARED SPECTROPHOTOMETER is making possible new analytical and control methods in many of today's industrial processes. Developed originally to simplify plant control methods in the refining of butadiene and aviation gasolines, Infrared equipment proved so valuable in saving time and stepping up the efficiency of plant processing operations that other industries wanted similar Beckman equipment for simplifying their analytical and control problems.

As a result of this widespread demand—and backed by the invaluable experience gained by Beckman engineers in building more Infrared Spectrophotometers than all other makes combined—the Beckman IR2 Spectrophotometer was developed. This instrument, besides embodying the advancements of the original Beckman Infrared instrument, incorporates other advancements that extend the advantages of infrared analytical and control methods to much broader fields of application.

The Beckman IR2 Infrared Spectrophotometer is years ahead of any other infrared equipment because into its design Beckman engineers have incorporated the ideas, user-suggestions and first-hand experience gained from the long period of pioneer work in butadiene and 100-octane applications—two of industry's greatest war-time achievements. To enable you to fully understand the really important advancements incorporated into the IR2, a new twelve page Beckman Bulletin has been issued describing the IR2 in detail. A copy of this Bulletin will gladly be sent you on request. Write today while ample supplies are available. *Beckman Instruments,*

NATIONAL TECHNICAL LABORATORIES
South Pasadena 25, California

A FEW OF THE IR2 ADVANCEMENTS DESCRIBED AND ILLUSTRATED IN THIS BULLETIN

MAXIMUM VERSATILITY: Illustrations and descriptive matter show how the IR2 handles liquid and solid samples as well as gases . . . how its light sources, cell holders and other elements are interchangeable . . . how these and other features insure maximum adaptability to varying applications.

ELIMINATION OF FALSE ENERGY AND ZERO DRIFT: This important feature is described, and illustrated with typical data and charts.

ELIMINATION OF TEMPERATURE CORRECTION: The method of thermostatting the instrument against temperature variations is described and the importance of this feature explained.

ELIMINATION OF GALVANOMETERS: Beam modulation, energy receiver and electronic amplifier are described, showing how they eliminate the temperature, non-linearity and vibration difficulties associated with galvanometers.

IN ADDITION, internal views of the instrument, light path diagrams, typical recorded curves and many other valuable IR2 features are contained in this Bulletin. It is an invaluable aid to anyone contemplating the purchase of infrared equipment for it gives detailed facts on the latest infrared advancements!

BECKMAN **INSTRUMENTS CONTROL MODERN INDUSTRIES**

PEERLESS
(Formerly Dayton-Dowd)
CENTRIFUGAL PUMPS

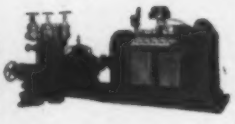
Built for Regular or Special Pumping Applications where Temperatures and Pressures are Variable, and Normal, Dense or Viscous Liquids are to be Handled. Types illustrated represent a few of scores of Peerless Pumps for industrial applications.

PEERLESS PUMPS

Type A CENTRIFUGAL PUMPS
For general services. Capacities: Up to 50,000 g.p.m.

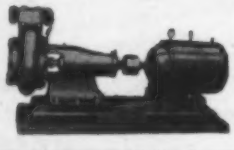
Type B CENTRIFUGAL PUMPS
For Boiler Feed, Refinery and Pipe Line Service. Pressures to 700 lbs.

Type AF FIRE PUMPS
Formerly Dayton-Dowd
Underwriters Approved. Capacities: Up to 2,000 g.p.m.



Type XT (VANE) PUMPS
For Butane-Propane, Processing and General Service. Capacities: Up to 150 g.p.m.

Type DS CENTRIFUGAL PUMPS
For Chemical, Oil, Food Processes, etc. Capacities: Up to 600 g.p.m.



PEERLESS UTILIZES ADVANCED PRINCIPLES OF HYDRO-DYNAMICS

Peerless Horizontal Centrifugal Pumps (formerly Dayton-Dowd) are available in sizes, pressures and capacities for practically all pumping services. Used to most efficiently serve applications in all industries where continuous, heavy duty pump performance is required affording long-lived, trouble-free service with a minimum of maintenance, attention and expense.

Contact or write your nearest Peerless distributor for engineering data and full details of Peerless Centrifugal Pump advantages.

PEERLESS
PUMP DIVISION
FOOD MACHINERY CORPORATION
Factories: 301 W. Ave. 26, Los Angeles 31, Calif.
Quincy, Illinois — Canton 6, Ohio

nology, and has been with the company 13 years. From Cleveland he will direct the company's activities in northern and eastern Ohio, western New York, and Erie, Pennsylvania. His offices are at 830 Vincent Avenue.

Davidson is a mechanical-engineering graduate of Texas Technological College, and has been connected with General Electric Company and with Kellex Corporation. His St. Louis headquarters are at 812 Olive Street, and he will direct activities in eastern Missouri, southern Illinois and western Kentucky.

Royer Heads Chemical Items Sales for U. S. Stoneware

Announcement of the appointment of Hubert Royer as sales manager of the Chemical Stoneware Division of The United States Stoneware Company, Akron, Ohio, has been made by Howard Farkas, vice president and general sales manager of the company.

Hubert Royer

Royer for the past 27 years has been a sales engineer for General Ceramics & Steatite Corporation. In his new position he will be located at the New York office of the company, at 60 East 42nd Street.

Beane Appointed Sales Manager of Bristol Company

H. E. Beane has been appointed general sales manager of The Bristol Company, Waterbury, Connecticut.

Starting as a sales engineer, Beane has been associated with The Bristol Company since 1920. From 1925 to 1935, he was district manager of various branch offices of the company. He became field sales manager in 1936, and sales manager in 1943.

Clark to Represent Hammond Iron Works in Southwest

Appointment of Harry E. Clark & Company, Houston, as its Southwest representative is announced by Hammond Iron Works, Warren, Pennsylvania. Clark will represent the full line of Hammond services.

Vapor Recovery Systems Closes Tulsa Office

John L. Shaunty, Mid-Continent manager of Vapor Recovery Systems Company, M. & M. Building, Houston, is in charge of the company's business in the Tulsa area since closing of its Tulsa office.

Northern Equipment Company Announces Promotions

William L. Hunter, formerly chief engineer, has been named general manager for Northern Equipment Company, Erie, Pennsylvania. A graduate of the University of Tennessee who served with the artillery in France during World War I, he joined the company in 1926. He is a member of American Society of Mechanical Engineers.

Harold A. Schlieder, who has been with Northern Equipment Company since 1936, succeeds Hunter as chief en-

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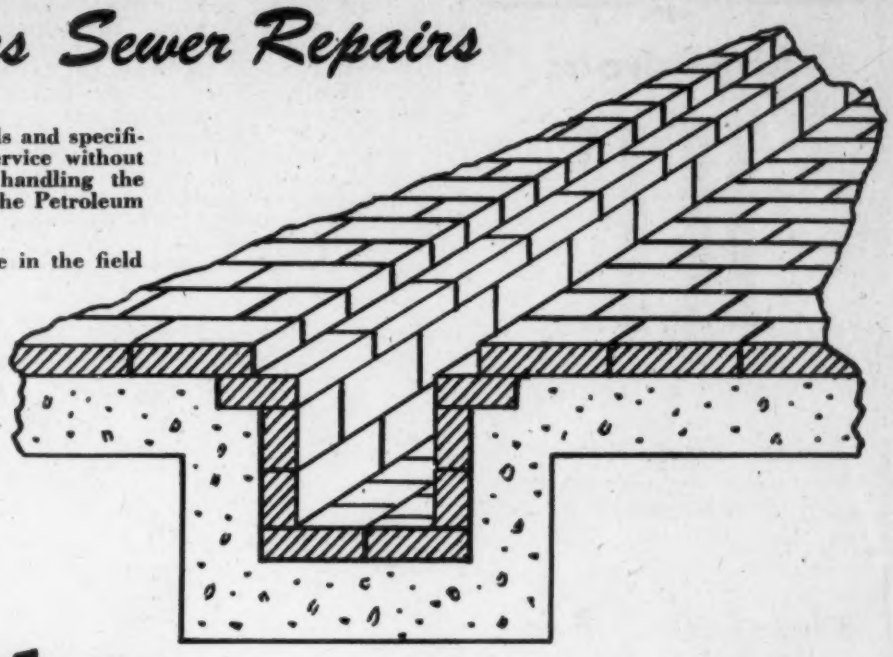

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gineer. He graduated from Rensselaer Polytechnic Institute. From 1938 to 1941 he was in charge of company activities in the Far East and has more recently been in charge of foreign engineering. He is a member of American Society of Mechanical Engineers, American Institute of Electrical Engineers and National Society of Professional Engineers.

Francis W. Bunting, who joined the company as a service engineer in 1935, has been appointed assistant chief engineer. He is a graduate of Drexel Institute of Technology, and is a member of American Society of Mechanical Engineers and National Society of Professional Engineers.

Swaney Elected President Kerotest Manufacturing Company

Walter G. Swaney was elected president of Kerotest Manufacturing Company, Pittsburgh, Pennsylvania, and Stanley J. Roush became executive vice president, at a special meeting of the board of directors on January 23. Edward G. Mueller, former president, became chairman of the board. Other officers elected include A. W. Anderson, works manager and director of purchases, and Ralph E. Lane, secretary-treasurer.

W. G. Swaney

Swaney was one of the original members of the firm, having started as a clerk in 1905.

Ed Soph Opens Sales Office in Houston

Ed Soph has established an office at 708 Neils Esperson Building, Houston, and from that location represents A. R. Wilfley & Sons, Inc., and Hills-McCanna Company.

Wiseman Elected Director The Fluor Corporation

James P. Wiseman, general sales manager of The Fluor Corporation, Ltd., has been appointed to the board of directors. Wiseman, who has been with the company four years, was placed in charge of the sales division last September.

Oxygen Seen as New Tool for Industry

Improved methods of generating oxygen will be among the most important coming developments in industry, according to the report of Earl P. Stevenson, president of Arthur D. Little, Inc., Cambridge, Massachusetts, at its annual meeting. As a result of wartime advances in methods of making oxygen, at Massachusetts Institute of Technology and and elsewhere, it is now possible to build small plants which can be installed in consuming factories and eliminate the expensive transportation of oxygen. As a further result of this work, large oxygen plants can be built for new uses never before seriously contemplated. One such large plant will produce oxygen for use in making synthetic gasoline; its planned capacity is almost as great as that of all other United States oxygen production. Other potential applications are in steel production and fuel-gas manufacture. Arthur D. Little, Inc., has under way several projects on methods of generating and using oxygen.

Research at very low temperatures will be made easier by the Collins Helium Cryostat, which can maintain any temperature down to that of liquid helium, 457° below zero, Fahrenheit, Stevenson reported. Arthur D. Little, Inc., has undertaken to construct several of these newly developed instruments for industrial and institutional laboratories. In addition, the company plans itself to inaugurate a program of research at low temperatures, where it is possible to observe many phenomena which are obscured by the effects of heat at higher temperatures.

The following company officers were elected: Earl P. Stevenson, president; Raymond Stevens, and Thorne L. Wheeler, vice presidents; Henry G. Powning, treasurer; and Frank N. Houghton, secretary. Directors for the coming year are Marshall B. Dalton, W. Cameron Forbes, Horace S. Ford, Roger C. Griffin, Royal Little, Henry G. Powning, Charles E. Spencer, Jr., Raymond Stevens, Earl P. Stevenson and Alexander Whiteside.

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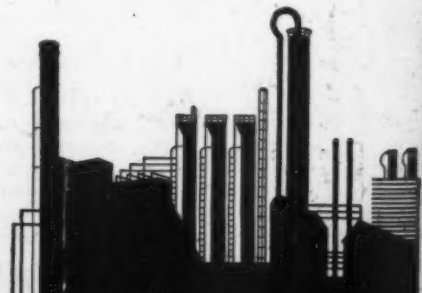

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